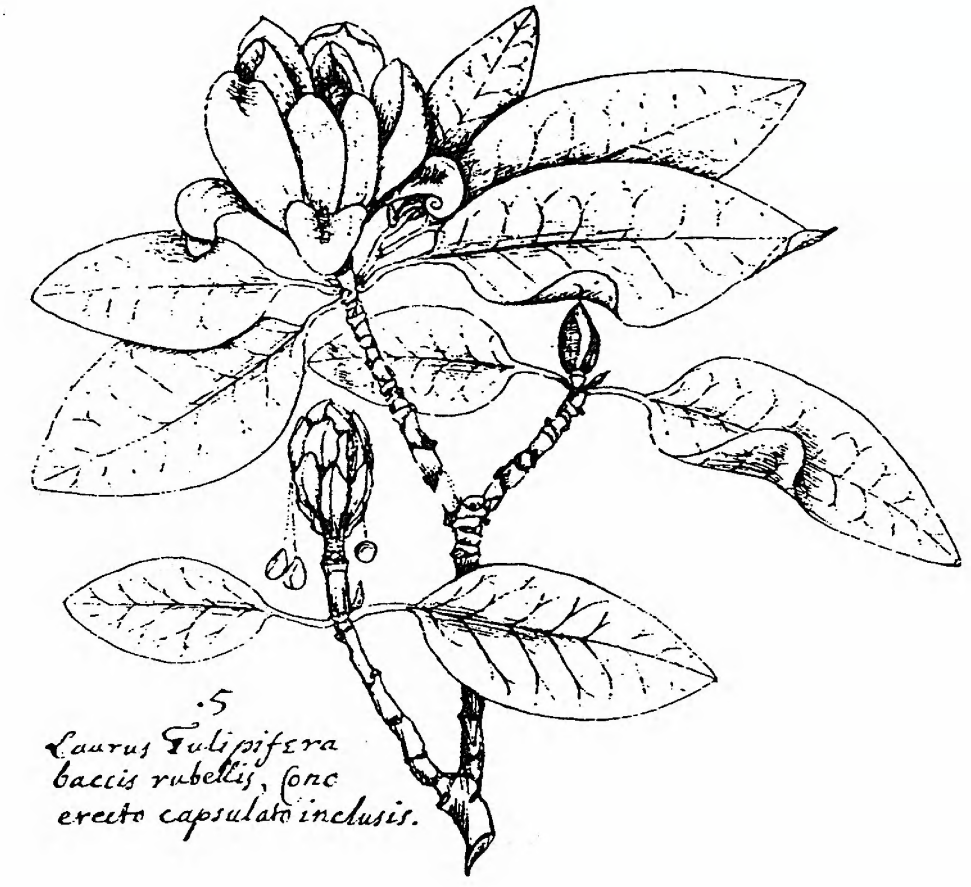
BANISTERIA

A JOURNAL DEVOTED TO THE NATURAL HISTORY OF VIRGINIA



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B A N I S T E R I A

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Cover: *Magnolia virginiana* Linnaeus (Sweetbay).

Inside back cover: *Asplenium rhizophyllum* Linnaeus (Walking Fern).

Back cover: *Gillenia trifoliata* (L.) Moench (Bowman's-root or Mountain Indian-physic).

Original drawings by John Banister, sent to Bishop D. H. Compton in 1689. Figures 90, 37, and 85, respectively, in folio in Sir Hans Sloane's MS 4002 in the British Museum. Photocopies courtesy of Joseph and Nesta Ewan.

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Banisteria, Number 47, pages 3-8

Digitizing Virginia's Herbaria: A Call to Citizen-scientists

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ABSTRACT

A consortium of 11 Virginia herbaria was funded by the National Science Foundation in 2014 to create a publicly-accessible online database of its ca. 300,000 Virginian herbarium specimens, including high-resolution digital images of all specimens. Participation by citizen-scientists is integral to the project plan. Members of the public help transcribe label data from the high-resolution digital images of the herbarium specimens into database fields via the crowd-sourcing platform, Notes from Nature (www.notesfromnature.com). This paper reviews the project's progress to date, shares links to this emerging resource for research and education, and issues a call to citizen-scientists to assist in liberating these important historical data about Virginia's flora.

Key words: plants, citizen-science, crowd-sourcing, biodiversity informatics, southeastern United States.

INTRODUCTION

Our growing knowledge of the flora of Virginia is integrally tied to herbaria, research collections that house archivally prepared plant specimens gathered and identified by taxonomic experts. Every species treatment in the *Flora of Virginia* (Weakley et al., 2012) and most of the occurrence records in the *Digital Atlas of the Virginia Flora* (Virginia Botanical Associates, 2016) are based on these physical vouchers (Fig. 1). Twenty-five active Virginian herbaria hold over 500,000 plant specimens dating from the 19th century to the present day and the majority of these specimens were collected in the state (Fig. 2). These institutions are a lasting source of our knowledge about plants in the Commonwealth; they and the people who contribute specimens to these collections are the engines of discovery.

However, the contents of Virginian herbaria have not been electronically accessible to researchers or the public until recently. None served their databases online nor could they provide high-resolution digital images of their specimens for virtual inspection. This deficiency has precluded Virginian herbaria from fully contributing to 21st century biodiversity informatics research, which aggregates records about the distribution, phenology, and ecology of plant species across large geographic regions through time, often for conservation purposes. Using these data to more accurately manage the preservation of native plant species in the face of habitat destruction, exotic species invasions, and rapidly shifting climate truly is a grand challenge for our times (Graham et al., 2004). Improving worldwide access to Virginian collections should also speed taxonomic discovery because over 80% of new species are recognized and uncovered for the first time in herbarium collections rather than in the field (Bebber et al., 2010).

As a first step toward liberating these data for the Commonwealth, the National Science Foundation has funded the digitization of 11 Virginian herbaria as part of a larger research collaboration among botanists in the southeastern US entitled, "The Key to the Cabinets: Building and Sustaining a Research Database for a Global Biodiversity Hotspot." The plan of digitization work includes collecting high-resolution digital images for all specimens and establishing publicly accessible databases of each herbarium's holdings according to best-practices developed by the natural history collections community (Nelson et al., 2015). The participation of citizen-scientists is integral to this plan.

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Fig. 1. Screenshot of an herbarium specimen image on the "Plants of Virginia" expedition hosted by the Notes from Nature crowd-sourcing platform (http://www.notesfromnature.org). This site allows citizen-scientists to transcribe label data from images of herbarium specimens to build a publicly-accessible database of the contents of Virginian herbaria (http://www.sernecportal.org).

Members of the public transcribe label data from the high-resolution digital images into database fields via the online platform Notes from Nature (www.notesfromnature.com). This method of accessing labor across the internet, which is called crowd-sourcing, is expected to help digitize over 4.5 million southeastern US herbarium specimens from 106 US herbaria.

HERBARIUM DIGITIZATION IN VIRGINIA: INSTITUTIONAL PARTICIPANTS AND DATA MANAGEMENT

The 11 Virginian herbaria included for digitization as part of the "Key to the Cabinets" grant comprise both mid- and small-sized collections distributed across the state and are estimated to house ca. 300,000 specimens collected in the Commonwealth. These include herbaria at Virginia Polytechnic Institute and State University (VPI, 75,600; Index Herbariorum acronym from Thiers [2016], estimated number of Virginian specimens, respectively), Longwood University (FARM, 58,650), George Mason University (GMUF, 45,500), Lynchburg College (LYN, 44,800), Virginia Military Institute (VMI, 21,000), University of Richmond (URV, 14,000), Lord Fairfax Community College (LFCC, 14,000), James Madison University (JMU, 12,600), Virginia Commonwealth University (VCU [housed at Lewis Ginter Botanical Garden], 11,900), the City of Alexandria Herbarium (AVCH, 4,500), and Bridgewater College (BDWR, 4,000). Two digital imaging stations rotate among these herbaria, which allow rapid capture of high-resolution digital images of herbarium specimens during the creation of skeletal database records. Digitized specimens are barcoded, and the unique barcode value links skeletal database records with the high-resolution image files. Curators of the collections and undergraduate student-workers primarily collect these data and manage their dissemination.

The high-throughput data collection and management workflow balances the need to share data publicly while protecting data about legally-protected or otherwise sensitive species (Fig. 3). In step 1, a digital image of each specimen is taken with a 25 megapixel digital SLR camera and a minimal database entry about the specimen is created online containing its barcode number, species name, and the state in which it was collected. Each herbarium has a publicly accessible database within the SouthEast Regional Network of Expertise and Collections (SERNEC) portal (www.sernecportal.org), whose administrative controls are under the direction of the individual curator (step 2). For each specimen, the high-resolution digital image and the database record are displayed together. In step 3, data are filtered to exclude detailed information about legally-protected or otherwise sensitive taxa from being viewed by the public. This customizable filter, represented by the dotted lines in Figure 3, obscures the high-resolution digital image of the specimen and any detailed locality data. Curators evaluate direct requests for sensitive data from the public on a case-by-case basis and can adjust data access permissions for individual researchers within the SERNEC portal. In step 4, the high-resolution digital image of each specimen is sent to Notes from Nature for the full transcription of its remaining label data. In step 5, the Notes from Nature citizen-science platform guides participants through transcribing label data into database fields including: county, locality, ecological information, date collected, collector, and collector number (Fig. 1). Label data from each specimen are transcribed three times by different users and a computer algorithm creates the most correct transcription, which is returned to the SERNEC portal database in step 6. In step 7, all image and text data

acronym	size	institution
VPI	109,000	Virginia Tech
WILLI	78,900	The College of William and Mary
FARM	75,000	Longwood University
GMUF	60,000	George Mason University
LYN	60,000	Lynchburg College
VMIL	30,000	Virginia Military Institute
ODU	28,000	Old Dominion University
LFCC	20,000	Lord Fairfax Community College
URV	18,000	University of Richmond
VCU	17,700	Virginia Commonwealth University
JMUH	15,000	James Madison University
RMWC	13,000	Randolph College
RUHV	7,000	Radford University
AVCH	4,500	City of Alexandria Herbarium
MWCF	4,500	Mary Washington College
BDWR	4,293	Bridgewater College
CVCW	4,000	Clinch Valley College, UVa
SARC	3,544	Roanoke College

acronym	size	institution
VDAC	3,400	VA Dept. Agriculture & Consumer Services
VA	3,000	University of Virginia, Mountain Lake
EHCV	2,500	Emory and Henry College
HAVI	2,500	Eastern Mennonite University
WYCO	2,500	Wytheville Community College
ROAN	1,200	Virginia Western Community College
PGC	1,125	The Petersburg Garden Club

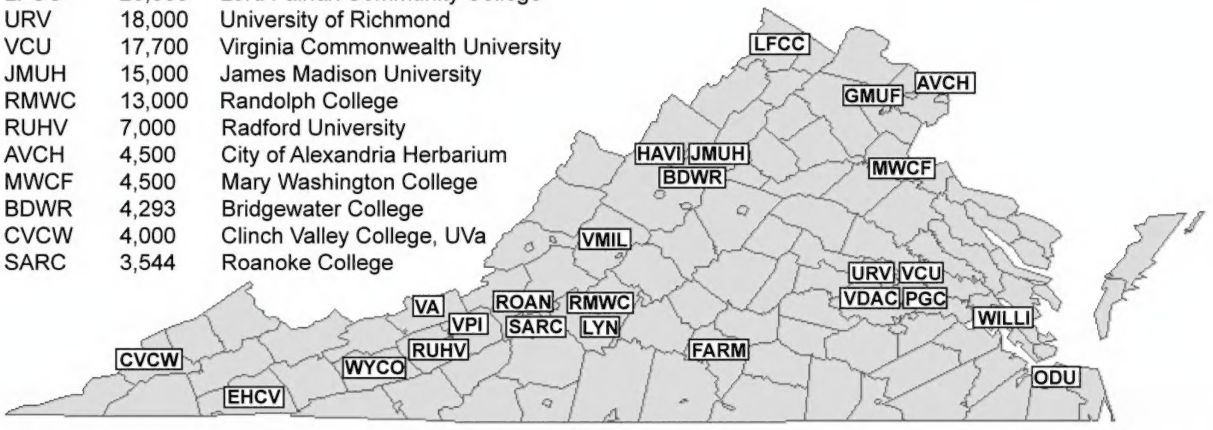

Fig. 2. Distribution and size of the 25 active herbaria in Virginia. Data compiled from *Index Herbariorum* (Thiers, 2016).

within from the SERNEC portal database are shared with the Global Biodiversity Information Facility (www.gbif.org), an international clearinghouse for biodiversity specimen data that is freely accessible to the public (step 8).

PROGRESS TO DATE: DIGITIZATION IN VIRGINIA

In the two years since the inception of the "Key to the Cabinets" herbarium digitization project all steps in the data collection and management workflow have become operational and there is evidence that the new database resource is leading to new inquiries and insights about the specimens. Within Virginia, seven of the original 11 herbaria have completed imaging (GMUF) or are in the process of imaging their specimens (VPI, FARM, LYN, URV, JMUH, AVCH). Two additional herbaria housed at the College of William and Mary (WILLI) and the University of Mary Washington (MWCF), now share their data through the SERNEC portal, as well. As of September 2016, 145,376 database records have been created and 50,170 high-resolution digital images of Virginia-collected herbarium specimens have been uploaded to the site. For example, high-throughput digitization of GMUF took approximately 393 hours at an average rate of 92 specimens/hour and yielded 35,351 unique database entries and images on the GMUF SERNEC portal database. Since completing the digitization process, GMUF has received requests for loans of specimens from researchers who have been able to preview images of targeted specimens. Surprisingly, the number of Virginian specimens held by GMUF was revealed to be 22% smaller than originally estimated. Anecdotal reports from other herbaria in the process of digitizing suggest this trend may be common and result in a smaller final dataset for Virginia than originally anticipated.

PROGRESS TO DATE: PROTECTING DATA ABOUT SENSITIVE VIRGINIAN PLANT TAXA

A key step in completing the data management workflow included creating the filters that redact from public view detailed information about sensitive Virginian plant taxa. The SERNEC portal includes two tiers of filters: a higher-level filter that can redact specimen data held by any participating herbaria and a lower-level filter that is specific to individual herbaria. In all cases, curators have full authority to redact or release records of any specimen in their collection. The rationale for creating higher-level filters is to provide a minimal level of protection at the outset of the digitization process for sensitive plant taxa in all participating SERNEC herbaria. For example, detailed locality information and images of all federally-protected plant species are automatically redacted by

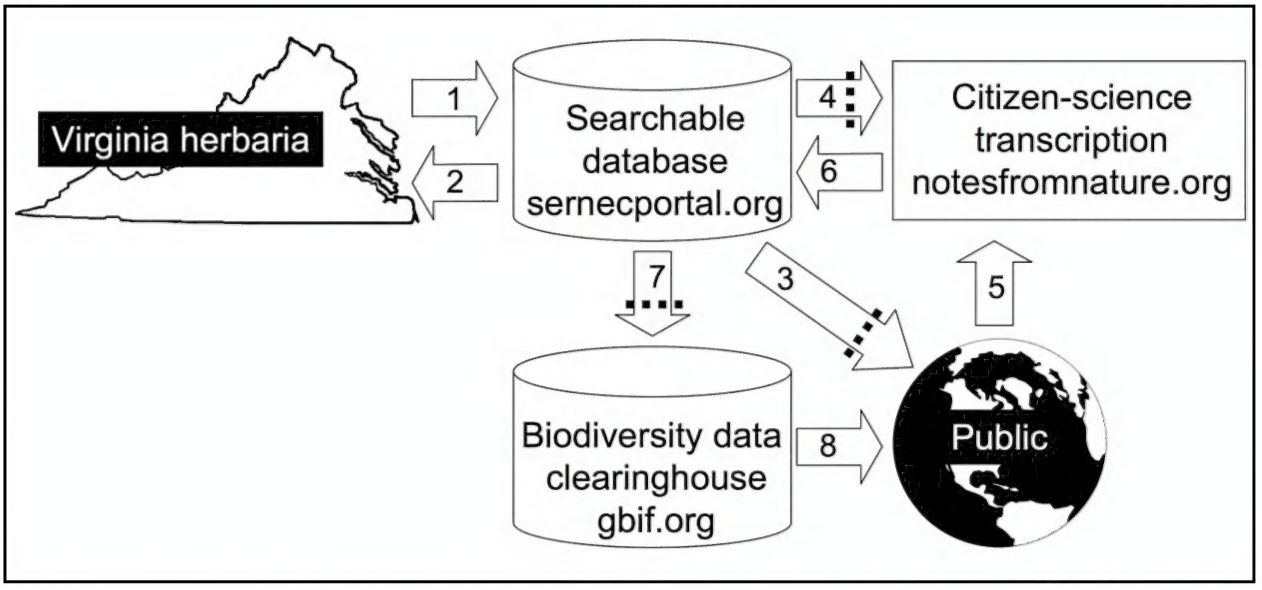

Fig. 3. The data collection and management workflow for herbarium digitization, charting the liberation of herbarium specimen data held by individual herbaria to the public at large. Dotted lines represent customized filters that protect the image and detailed locality data about sensitive plant taxa from unregulated exposure to the public.

the SERNEC portal. Although redacted data are not viewable by the public, the data remain in the database and can be accessed by individuals who are given additional permissions within the herbarium collection that holds the specimens of interest. Herbarium curators receive requests from potential researchers and control permissions.

The higher-level sensitive taxon filter for Virginia-collected plants was expanded to include the 12 taxa that have threatened or endangered status only within the state as well as 35 taxa that are commonly harvested from the wild for medicinal or horticultural purposes (Table 1). As a consequence of both Federal and state-level filters, the images and detailed locality data for 60 sensitive plant taxa native to Virginia are automatically and immediately redacted from public view across the SERNEC portal. Filters also capture taxonomic synonyms since sensitive specimens are often filed under different names depending on the herbarium.

PROGRESS TO DATE: OUTREACH AND EDUCATION IN VIRGINIA

Participation by citizen-scientists on the crowd-sourcing platform Notes from Nature is integral to the success of the "Key to the Cabinets" herbarium digitization project as is the full dissemination of the digitized data to researchers around the world. Digital images of specimens from Virginian herbaria needing label transcription are presented on the Notes from Nature platform within projects entitled, "Plants of Virginia." The projects bundle ca. 5,000 specimen images following a theme, such as taxonomy, geography or ecology, and are termed "expeditions" by the Notes from Nature platform. Results from completed Plants of Virginia expeditions indicate that thousands of label transcriptions can be accomplished in a matter of days via this method of crowd-sourcing. In the last two years, presentations and workshops about the project and the Notes from Nature crowd-sourcing platform have been organized for non-academic interest groups including the Virginia Native Plant Society and the Virginia Master Naturalists, for whom Notes from Nature participation now fulfills continuing education credit. Presentations and workshops have also been delivered to academic and scientific research audiences at the annual meetings of the Association of Southeastern Biologists, Virginia Academy of Science, Virginia Association for Environmental Education, and the Virginia Botanical Associates, which includes staff from the Virginia Natural Heritage Program. Two school lesson plans incorporating the Notes from Nature crowd-sourcing platform appropriate for grades 6-8 and 9-12 also have been developed and disseminated online (http://sernec.appstate.edu/education-outreach). Each lesson plan incorporates several of Virginia's Standards of Learning for science and biology.

Table 1. List of native Virginian plant taxa filtered by the SERNEC database portal (www.sernecportal.org). If herbarium specimens of these taxa were collected from the state of Virginia and are present within the database, the filter will automatically obscure from public view the herbarium specimen image and detailed locality information. Synonyms for the listed taxa (not included here) are also captured by the filter. LE = legally endangered; LT = legally threatened.

Scientific name	**Common name**	**Conservation Status**
Federally threatened or endangered		
Aeschynomene virginica Britton & Stern et Poggenb.	Sensitive Joint-vetch	LT
Amaranthus pumilus Raf.	Sea-beach Amaranth	LT
Arabis serotina Steele	Shale Barren Rock Cress	LE
Betula uber (Ashe) Fernald	Virginia Roundleaf Birch	LT
Cardamine micranthera Rollins	Small-anthered Bittercress	LE
Echinacea laevigata (C.L. Boynt. & Beadle) S.F. Blake	Smooth Coneflower	LE
Helenium virginicum Blake	Virginia Sneezeweed	LT
Helonias bullata L.	Swamp-pink	LT
Houstonia montana Small	Roan Mountain Bluet	LE
Iliamna corei Sherff	Peters Mountain Mallow	LE
Isotria medeoloides (Pursh) Raf.	Small Whorled Pogonia	LT
Platanthera leucophaea (Nutt.) Lindl.	Prairie Fringed Orchid	LT
Ptilimnium nodosum (Rose) Mathias	Harperella	LE
Rhus michauxii Sarg.	Michaux's Sumac	LE
Schwalbea americana L.	Chaffseed	LE
Scirpus ancistrochaetus Schuyler	Northeastern Bulrush	LE
Spiraea virginiana Britton	Virginia Spiraea	LT
Virginia-only threatened or endangered		
Boltonia montana J.F. Townsend & V. Karaman-Castro	Valley Doll's-daisy	LE
Carex juniperorum Catling, Reznicek, & Crins	Juniper Sedge	LE
Clematis viticaulis Steele	Millboro Leatherflower	LT
Corallorhiza bentleyi Freudenstein	Bentley's Coralroot	LE
Fimbristylis perpusilla Harper *ex* Small & Britt.	Harper's Fimbry	LE
Ilex collina Alexander	Long-stalked Holly	LE
Isoetes virginica N.E. Pfeiffer	Virginia Quillwort	LE
Juncus caesariensis Coville	New Jersey Rush	LT
Nuphar sagittifolia (Walt.) Pursh	Narrow-leaved Spatterdock	LT
Panax quinquefolium L.	Ginseng	LT
Scirpus flaccidifolius (Fern.) Schuyler	Reclining Bulrush	LT
Trifolium calcaricum Collins & Wieboldt	Running Glade Clover	LE
Other Virginian species commonly wild-harvested		
Actaea racemosa L.	Black Cohosh	none
Aletris farinosa L.	Colicroot	none
Allium burdickii (Hanes) A.G. Jones	White Ramps	none
Allium tricoccum Ait.	Red Ramps	none
Caulophyllum thalictroides (L.) Michx.	Blue Cohosh	none
Chamaelirium luteum (L.) Gray	Devil's-bit	none
Cypripedium acaule Aiton	Pink Lady's-slipper	none
Cypripedium candidum Muhl. ex Willd.	Small White Lady's-slipper	State Rare
Cypripedium kentuckiense C.F. Reed	Kentucky Lady's-slipper	State Rare
Cypripedium parviflorum Salisb. var. *pubescens* (Willd.) Knight	Large Yellow Lady's-slipper	none
Cypripedium reginae Walter	Showy Lady's-slipper	State Rare
Echinacea pallida (Nutt.) Nutt.	Pale Purple Coneflower	none
Echinacea purpurea (L.) Moench	Purple Coneflower	none
Endodeca serpentaria (L.) Raf.	Virginia snakeroot	none
Galax urceolata (Poir) Brummit	Galax	none
Hydrastis canadensis L.	Goldenseal	State Watch-list
Liatris helleri T.C. Porter	Heller's blazing-star	none
Sanguinaria canadensis L.	Bloodroot	none
Sarracenia flava L.	Yellow Pitcher Plant	State Rare
Sarracenia purpurea L.	Northern Pitcher Plant	State Rare
Shortia galacifolia Torry & A. Gray var. *galacifolia*	Shortia	none
Trillium cernuum L.	Nodding Trillium	State Rare
Trillium erectum L.	Red Trillium	none
Trillium flexipes Raf.	Drooping Trillium	State Rare
Trillium grandiflorum (Michx.) Salisb.	Great White Trillium	none
Trillium luteum (Muhl.) Harbison	Yellow Toad-shade	none
Trillium nivale Riddell	Snow Trillium	State Rare
Trillium pusillum Michx. var. *virginianum* Fern.	Virginia Least Trillium	State Rare
Trillium sessile L.	Sessile Trillium	none
Trillium sulcatum Patrick	Southern Red Trillium	none
Trillium undulatum Willd.	Painted Trillium	none

LOOKING TO THE FUTURE: A CALL TO CITIZEN-SCIENTISTS

Bringing to light more than 200 years of detailed information about the botanical diversity of Virginia is both a logistical challenge and a remarkable opportunity to advance research and education about the state's flora. The "Key to the Cabinets" herbarium digitization project is employing many technological advances that will partially address this grand challenge in a reasonable timeframe, including efficient digital image processing, flexible information architecture, and distributed computing. Yet, arguably none has greater power to speed this process than crowd-sourced label transcription (Ellwood et al., 2015), such as that facilitated by the Notes from Nature platform. During crowd-sourcing, many people contribute a small amount of labor each to accomplish a large task collectively and often quite rapidly. Viewed from this perspective, crowd-sourcing is a resource-efficient strategy for collecting data. However, crowd-sourcing is also an innovative method for outreach and education. Engaging volunteers in crowd-sourcing can build communities of citizen-scientists, expand awareness of and support for the scientific merits of the research project outside of academia as well as provide a launching pad for training the next-generation of scientists. The Notes from Nature platform facilitates communication among all stakeholders in addition to guiding rapid transcription of label data by volunteers. Readers of *Banisteria* are encouraged to participate in Notes from Nature to hasten the process of liberating important historical data about Virginia's diverse flora. A tutorial is available within the "Plants of Virginia" expeditions and an instructional webinar on the transcription process is available through the Virginia Master Naturalist's website: http://www.virginiamasternaturalist.org/continuing-education.html.

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Banisteria, Number 47, pages 9-13

The Small Mammals of Southeastern Virginia as Revealed by Pitfall Trapping

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ABSTRACT

Pitfall trapping is a poor method to catch small mammals but the only way to catch and study the Southeastern Shrew (*Sorex longirostris*), the primary mammal of interest in the field studies reported here. While learning much about its distribution and abundance, still more was learned about the other small mammals present in forests and fields of eastern Virginia. A total of 15 species was captured at 19 locations during the 1990-2013 period, including five shrews, two moles, and eight rodents, representing all but one of the common small mammals in eastern Virginia.

Key words: moles, pitfall trapping, rodents, shrews, small mammals, Virginia.

INTRODUCTION

Pitfall trapping is a useful but labor-intensive method to census ground-dwelling animals, such as insects that cannot be collected in light traps or with sweep nets, or animals such as amphibians and snakes that do not respond to baited traps. As the name implies, pitfall traps, whether cups, cans, or buckets, are placed in the ground flush with the soil surface and the animal blunders in or is guided to the trap by constructed drift fences. The catch rate of pitfall traps is highly variable and determined by population density, season, and even weather factors.

I first used pitfall traps in February 1980 when, with the help of Old Dominion University undergraduates Rosalind Bowman and David Harrelson, we placed pitfall traps under a powerline in the northwest section of the Great Dismal Swamp National Wildlife Refuge (GDSNWR) in Suffolk, Virginia, in an attempt to collect *Synaptomys cooperi helaletes*, the Dismal Swamp subspecies of Southern Bog Lemming. Using specimens collected in 1895 by the US Biological Survey, C. Hart Merriam (1896) had described the Dismal Swamp form as a new species, but Wetzel (1955), in a revision of the genus, demoted *S. c. helaletes* to a subspecies. More importantly, lemmings had not been collected in the Dismal Swamp in the 20th Century, despite field efforts by Charles O. Handley, mammal curator of the US National Museum of Natural History, and others. Our purpose in using pitfall traps in the Refuge was to learn whether *S. c. helaletes* was still present in the Dismal Swamp, and our results confirmed that it was (Rose, 1981).

Pitfall traps for small mammals were first used intensively by Tuttle (1964) for collecting shrews in Tennessee. French (1980) popularized the method in his studies of shrews in Alabama, where he caught dozens of Southeastern Shrews (*Sorex longirostris*), a supposedly rare mammal. At the time, the one or two state records in several southeastern states were for specimens found dead on the ground or drowned in downspout basins, but never caught in traps.

Among the small mammals we trapped in 1980, besides Southern Bog Lemmings, were the first 20th Century specimens of *Sorex longirostris fisheri*, another distinctive Dismal Swamp subspecies with a similar collection and taxonomic history to *S. c. helaletes*. After receiving grant support from the US Fish and Wildlife Service's Office of Endangered Species, my graduate students and I began extensive studies of *S. l. fisheri*, at first centering on the GDSNWR and later more broadly, in order to learn details of abundance, distribution, and habitat for this long-tailed shrew. In 1986, the US Fish and Wildlife Service listed the Dismal Swamp Southeastern Shrew as a "Threatened" species. As a result of this listing, construction projects

planned for areas in potential shrew habitat were required to conduct surveys for the presence of the shrew, leading to a number of surveys that my students and I conducted using pitfall traps. The information presented in this paper is based on 19 such field surveys in southeastern Virginia. In our quest to learn the presence and other details of *S. l. fisheri,* we learned much about the distribution and habitats of the other small mammals in this region of Virginia. In fact, using pitfall traps we collected 15 species of small mammals, all but one (Marsh Rice Rat) of the common small mammals in eastern Virginia, including five shrew species, both moles, and eight species of rodents. (There are historic records of two other species from southeastern Virginia, *Peromyscus gossypinus* [Cotton Mouse] and *Zapus hudsonius* [Meadow Jumping Mouse], neither of which have I caught in Virginia.)

MATERIALS AND METHODS

In our efforts to learn details of the biology of the Southeastern Shrew we trapped in a range of seral habitats using #10 tin cans (23 cm tall, 15 cm diameter) as pitfalls, traps that we placed in a 5 by 5 grid, with 12.5 m intervals between traps. This grid encompassed an effective trapping area of 0.25 ha, and the repeated use of this design enabled us to determine relative densities among different sites and habitats. Using an Iwan auger, we drilled a hole in the ground that just accommodated the tin can; we then placed 5-8 cm of water in the can, in which the small mammals were drowned. Depending on season, we checked the traps once or twice a week for an extended period. During the first year we learned that little new information on small mammal abundance was obtained by trapping longer than 21 days, so our standard protocol for field sampling was established as a 0.25-ha grid of 25 pitfall traps for 21 days. Occasionally, flooding, which fills pitfall traps and renders them useless as traps, required extending the study beyond 21 days. By having used these standard methods throughout, it was possible to compare relative densities of small mammals across habitats and also to calculate capture rates (number of collected specimens divided by the total number of nights the traps were in the ground times 100, which yields the number of small mammals per 100 trap nights). One trap in place for one night equals one trap night.

These field studies were conducted during the 1990-2013 period in the cities of Virginia Beach, Chesapeake, and Suffolk, all large areas because each municipality had incorporated the area of its former county. This region of the Coastal Plain is low-lying, often with a high water table and winter flooding, and many soils are highly organic of Dismal Swamp type. Although old dunes and centuries of excavation and filling have created some upland habitats in the region, it is likely that some version of swamp forest dominated the region when Europeans arrived in the early 1600s.

All specimens collected in pitfall traps were returned to the lab, dried with paper towels, and then weighed (g) and standard measurements (mm) were taken. Each small mammal was given a catalog number, and detailed information was recorded, including such variables as number of embryos or testes weight. After removal of entrails and brain, the carcass was given a numbered skull tag, wrapped with thread, dried in a lab hood, and then stored in an insect-proof museum specimen case. Later, these dried specimens and copies of the related data forms were donated to museums, almost all to the US National Museum of Natural History.

RESULTS

Pitfall trapping at 19 sites yielded 15 species of small mammals, including five shrews, two moles, and eight rodents (Table 1). Some, such as Pygmy Shrew, Star-nosed Mole, and Golden Mouse, were taken at only one site, whereas others (Southeastern Shrew and Southern Short-tailed Shrew) were collected at more than half of the sites. These latter two shrews were also seen in greatest numbers (n = 58, 93), collectively comprising more than half of the total (n = 285). The totals for the five shrews (n = 203) were > 70 percent of the total catch.

Most sites for proposed construction projects were predominantly forested, resulting in the majority of study grids being placed in forests (87), compared to only 17 in early successional habitat or oldfields (Table 2). The grids in oldfields often yielded 5-7 species, compared to forested grids, which collectively yielded fewer species and individuals (Table 2). At Site 13 (Table 2), the single oldfield grid yielded the same number of species, seven, and more specimens, than the 16 forested grids. Overall, the oldfield grids yielded 164 small mammals (9.6 specimens per grid), whereas the more numerous forested grids yielded only 121 small mammals (1.4 specimens per grid). This crude comparison nicely describes the relative abundances of small mammals in field and forest.

The capture rates in oldfields and forests showed the same pattern as the number of specimens per grid: pitfall traps in oldfields (11,775 trap-nights) had a capture rate of 1.39 mammals per 100 trap-nights whereas forest pitfall traps (65,910 trap-nights) yielded only 0.18 mammals per 100 trap-nights. Even if the four forest sites (numbers 4, 6, 11, and 17) that yielded

Table 1. Small mammals collected with pitfall traps in southeastern Virginia, 1990-2013. A total of 15 species was collected at 19 survey locations, including five shrews, two moles, and eight rodents.

Scientific name/common name	# sites	# specimens #/site	# specimens Total
Cryptotis parva, Least Shrew	6	1–9	26
Sorex longirostris, Southeastern Shrew	11	1–19	58
Sorex hoyi, Pygmy Shrew	1	5	5
Blarina brevicauda, Short-tailed Shrew	4	2–8	21
Blarina carolinensis, Southern Short-tailed Shrew	12	1–36	93
Condylura cristata, Star-nosed Mole	1	1	1
Scalopus aquaticus, Eastern Mole	2	1	2
Reithrodontomys humulis, Eastern Harvest Mouse	6	1–13	26
Peromyscus leucopus, White-footed Mouse	7	1–6	16
Ochrotomys nuttalli, Golden Mouse	1	1	1
Sigmodon hispidus, Hispid Cotton Rat	2	1–2	3
Microtus pennsylvanicus, Meadow Vole	2	2–3	5
Microtus pinetorum, Woodland Vole	4	1–4	8
Synaptomys cooperi, Southern Bog Lemming	3	1–9	11
Mus musculus, House Mouse	4	1–5	9
Totals			285

Table 2. Numbers of species and specimens of small mammals collected in pitfall traps at each of 19 sites in southeastern Virginia, 1990-2013; locations are given numbers to protect their anonymity. Seventeen grids placed in oldfields yielded 164 small mammals and 87 grids in forests yielded 121 small mammals. Sites with no specimens are denoted with an asterisk.

Site Number	# species	oldfield habitats		forested habitats	
		# grids	#species/specimens	# grids	# species/specimens
1	7	5	7/38	5	4/22
2	2	0		4	2/3
3	8	1	5/13	5	4/14
4*	0	0		2	0/0
5	8	5	7/42	5	6/13
6*	0	0		4	0/0
7	3	0		1	3/4
8	2	0		1	2/2
9	2	0		1	2/2
10	1	0		2	1/3
11*	0	0		1	0/0
12	3	2	2/2	5	2/2
13	7	1	7/23	16	5/22
14	5	0		6	5/9
15	4	0		7	4/5
16	2	0		7	2/9
17*	0	0		2	0/0
18	7	2	6/42	6	3/4
19	5	1	2/4	7	4/7
TOTALS		17	164 mammals	87	121 mammals

no small mammals were excluded from the calculation, the catch rate would be only slightly higher, 0.21 mammals per 100 trap-nights. This rate equates to about 1 mammal for the 21-day trapping period on the grid.

DISCUSSION

Despite the low capture rate, pitfall trapping did reveal that the Southeastern Shrew (a long-tailed shrew averaging 100 mm and 4-5 g) has a broad distribution in the region, and confirmed that higher densities are present in oldfields than in forests. Sometimes the Southeastern Shrew was numerous (e.g., n = 10, 16, 19 per site), which conformed to earlier studies conducted in and near the GDSNWR (Rose et al., 1990); sometimes it was the most numerous species. The Southern Short-tailed Shrew was even more numerous and widespread in oldfields than in forests (Table 1). This shrew averages 100 mm and 10 g, compared to 120 mm and 18 g for *Blarina brevicauda,* the largest shrew species in North America. The Least Shrew is more predictably restricted to upland habitats, usually oldfields with mineral soils. Of all the species in eastern Virginia, the Least Shrew has the greatest fidelity to a type of habitat: fairly dry, upland oldfields. The Pygmy Shrew, at 70 mm and 2-3 g the smallest North American shrew and one of the world's smallest, was found in pine forest. This shrew, also taken only with pitfall traps, has a patchy distribution in the Coastal Plain of Virginia and North Carolina (Padgett & Rose, 1994) but, like the Southeastern Shrew, also occupies a range of habitats.

Relatively little is known about the distribution and abundance of the two moles in eastern Virginia. Star-nosed and Eastern Moles probably are equally common and occupy a range of habitats, their one universal requirement being a rich loamy or organic soil productive of earthworms, grubs, and other invertebrates which they obtain by "mining" the soil. Both moles are almost exclusively subterranean so their appearance in pitfall traps is unexpected.

I have given the sites numbers rather than names (Table 2) to protect the anonymity of the clients, which in some cases were municipalities, highway departments, or military facilities. Four of the 19 sites yielded no small mammals, usually due in part to the small area of a site and the resulting small number of grids, often only 1 or 2; one site was only 10 m by 35 m and accommodated transects rather than grids of traps. In other instances, the absence of mammals seemed to be attributable to the isolation of the site, such as a small forested plot surrounded by housing developments or farm fields, locations where it seemed possible that predation by House Cats or the dry conditions of forest edges had contributed to the disappearances of already small populations. Forests are known to support fewer species of small mammals than oldfield or shrub habitats, as well as low densities of those few species (Kirkland & Griffin, 1974).

In southeastern Virginia, the small mammal most predictably found in forests is the White-footed Mouse, an arboreal rodent that usually nests in tree holes (Batzli, 1977). The only other arboreal small mammal among the 15 regional species is the Golden Mouse (*Ochrotomys nuttalli*), which is found mostly in 8-10 year-old pine stands (Dolan & Rose, 2007; Rose, pers. obs.) or forest edge habitats (Rose & Stankavich, 2008) in eastern Virginia. As its name implies, the Woodland Vole (*Microtus pinetorum*) is another small mammal found (in low densities) in forests, but it sometimes achieves higher densities in early successional habitats in eastern Virginia (Rose & Ford, 2012).

The other small mammal species are more often associated with early successional habitats, where herbaceous stems and leaves, seeds, and insect foods are found in greater abundance. Fields dominated by grasses and forbs are the prime habitat for Meadow Voles, Hispid Cotton Rats, Eastern Harvest Mice, and sometimes Southern Bog Lemmings. The shrews would be mostly Least, Southeastern, and Southern Short-tailed. These rodents and shrews would comprise the typical small mammal community of approximately seven species found in oldfields, with the Southern Bog Lemming less often present (sedges and rushes and generally wetter conditions are better predictors for the lemmings–Rose, 2006, 2011). When the grasses disappear as secondary succession progresses, Meadow Voles disappear first, then Cotton Rats and probably the lemmings, leaving the habitat to the others, especially Eastern Harvest Mice, until Golden Mice and White-footed Mice arrive.

The one non-native small mammal, *Mus musculus*, the House Mouse, was mostly present in early successional (oldfield) habitat. An excellent colonizer of newly created grassy fields, the House Mouse exploits the bountiful seeds and insects for a season or two, then is displaced when Meadow Voles and other herbivorous mammals arrive in numbers. The Eastern Harvest Mouse, found in highest densities in oldfields, has broad habitat tolerances, and surprisingly is sometimes abundant in shrubby or forest-edge habitat and can be present almost anywhere. Mostly a seed and perhaps insect eater, this harvest mouse is tiny, with adults weighing about 8 g; they usually build small grassy nests in tufts of grass or low in shrubs. Finally, the one common small mammal not taken during these pitfall trapping studies was the Marsh Rice Rat,

Oryzomys palustris. As the name implies, this 80-g rodent is found mostly in marshes, many of which are tidal in eastern Virginia. Pitfall traps do not work when flooded, and so their absence was not unexpected, given the kinds of sites being surveyed in these studies.

In conclusion, the pitfall traps used for more than 75,000 trap-nights in these studies captured all but one of the common species of small mammal in eastern Virginia. The five shrew species comprised over half of the total small mammal captures, and oldfields yielded about seven times more small mammals than forests, whether based on number caught per grid or on catch rates.

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Banisteria, Number 47, pages 14-17

Recovery and Distribution of *Anthribus nebulosus*, a Scale Predator Introduced into Virginia in 1981

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ABSTRACT

Anthribus nebulosus Förster (Coleoptera: Anthribidae) is a scale predator native to Eurasia that was imported from Hungary in the 1970s and released in Virginia Beach, Virginia, in 1981 as a potential biological control against soft scale insects. First recovery of *A. nebulosus* in Virginia Beach occurred in 2010, 29 years after release. Subsequent surveys of soft-scale infested oaks over a 3-year period indicated that *A. nebulosus* had spread up to 32 km from the initial site in multiple cities and directions, but further spread was limited by geographic barriers.

Key words: Anthribus nebulosus, scale predator, Virginia.

INTRODUCTION

Anthribus nebulosus Förster (Coleoptera: Anthribidae) is one of two common European species that are predators of soft scale (Hemiptera: Coccidae) insects and their eggs (Valentine, 1998). Larvae and adults of *A. nebulosus* feed on all stages of soft scales. Its life history closely follows the life cycle of scale insects (Kosztarab & Kozar, 1983), with adults appearing in spring to lay a single egg inside the ovisacs of female soft scales. Egg hatch typically occurs in June and July, after which the larvae feed on soft scale eggs and nymphs and pupate under the female scale cover. In Europe, newly emerged adults enter diapause in August, hibernating in bark cracks or the empty ovisacs of host scale insects (Gonget, 2003).

Anthribus nebulosus preys on at least 15 species of scale insects in Europe and Central Asia, three of which are considered pest species in the eastern United States (Hoebeke & Wheeler, 1991). In the mid-Atlantic region, oak lecanium, *Parthenolecanium quercifex* (Fitch) (Hemiptera: Coccidae), is a frequent pest of oaks planted as urban street trees. Willow oak (*Quercus phellos* L.) is a shade tree widely planted in many street medians, parking lots, and parks throughout the region, and is commonly infested with oak lecanium and associated parasites and predators (Schultz, 1984; Robayo Camacho, 2015). Surveys after the 1981 Virginia releases of *A. nebulosus* determined that beetles released in Blacksburg survived and were recovered in low numbers (Hoebeke & Wheeler, 1991). Absent, however, was evidence confirming its establishment at or near the Virginia Beach release site (Hoebeke & Wheeler, 1991). This anthribid was collected from spruces (*Picea* spp.) infested with the coccid *Physokermes hemicryphus* (Dalman) at sites in the northeastern U.S. beginning in 1989, and in subsequent years from western Massachusetts and Connecticut to eastern New York (Hoebeke & Wheeler, 1991). The presence of large numbers of *A. nebulosus* in parts of Connecticut and Massachusetts, combined with none being found between there and Virginia, suggested that populations in New England were long-standing and adventitious, rather than the product of intentional releases (Hoebeke & Wheeler, 1991). The beetle is purported to have been accidentally introduced to the United States as early as the late nineteenth or early twentieth century, before passage of the Plant Quarantine Act of 1912 (Hoebeke & Wheeler, 1991). In 2010, *A. nebulosus* adults were collected from willow oaks heavily infested with oak lecanium at two sites in Virginia Beach within 6 km of the original release site. These unexpected collections on urban street trees

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prompted us to conduct additional surveys to delimit the establishment of the predator nearly three decades after its release. The objective of this study is to determine the adult activity period at the aforementioned two sites, and the extent of dispersal of *A. nebulosus* since its 1981 release.

MATERIALS AND METHODS

A survey was conducted in eastern Virginia from late March to July 2011 and 2012 and in northeastern North Carolina in 2013. A beat sheet used for sampling arboreal curculionids was used to survey for the presence of *A. nebulosus*. In 2011, monitoring was initiated weekly at the two sites (Site 1 = 36°52'23.8"N, 76°10'17.0"W and Site 2 = 36°53'50.2"N, 76°10' 53.3"W) in Virginia Beach 6 km from where 300 beetles were originally released in 1981. The survey radiated from the original release site in multiple directions wherever willow oak infested with oak lecanium was found on public property or with permission from a property owner. A scale-infested branch was struck several times with the beat sheet positioned beneath, and beetles were collected. The survey extended outward through adjoining municipalities and continued until *A. nebulosus* was no longer collected.

Concurrently, samples were taken from scale-infested trees with the predator present near the Hampton Roads Agricultural Research and Extension Center, Virginia Beach, VA each week to ensure that adults could still be recovered. Surveying was suspended in July 2011. Recovered adult beetles were counted and preserved in vials in 70% ethanol along with the date and site. Identification was confirmed and voucher specimens deposited in the Virginia Tech Insect Collection, Blacksburg, VA. Positive sites were used as a point of reference for extending the survey. In May 2012, surveying resumed and extended to additional sites in the cities of Virginia Beach, Chesapeake, Norfolk, Portsmouth, and Suffolk. In May 2013, monitoring extended southward into North Carolina and westward to sites beyond recovery points of the previous year.

RESULTS AND DISCUSSION

At the two sites where *A. nebulosus* initially was recovered in 2010, adults were found in low numbers in April of 2011 and 2012, with higher numbers between mid-May and late June (Figs. 1 and 2). Radiating out from the original release site in Virginia Beach

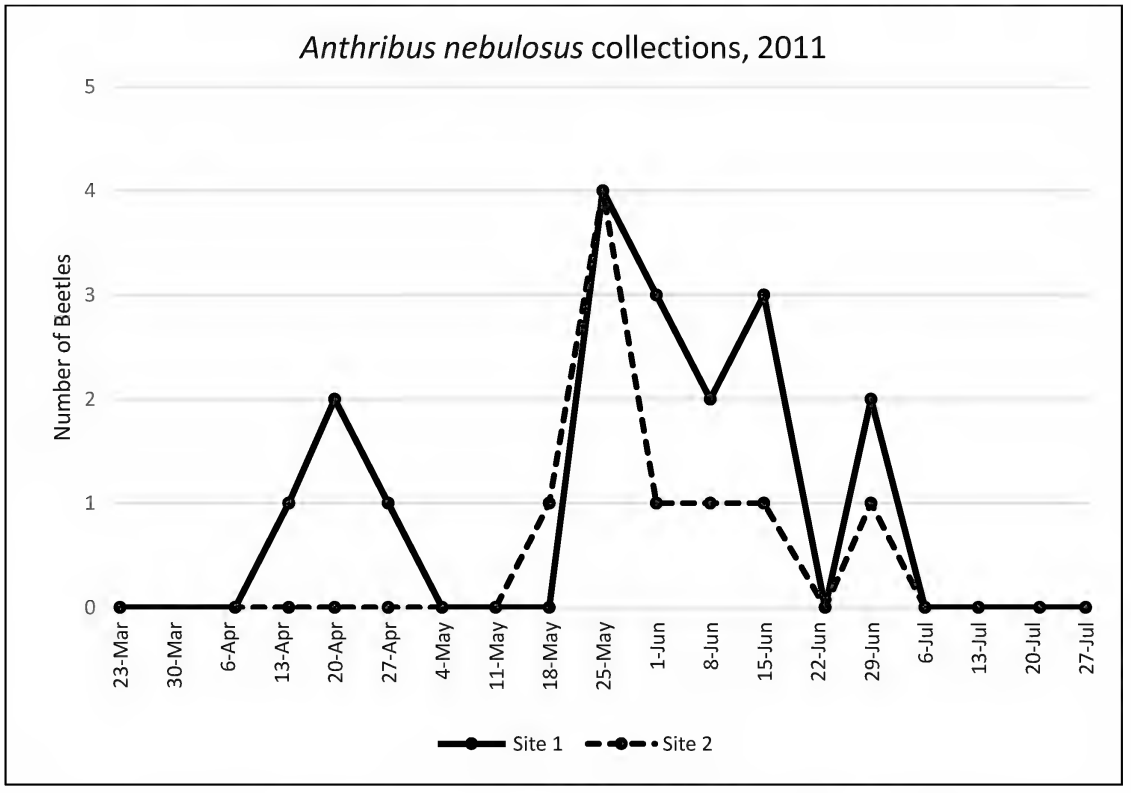

Fig. 1. *Anthribus nebulosus* adults collected from two sites in Virginia Beach, VA - 2011.

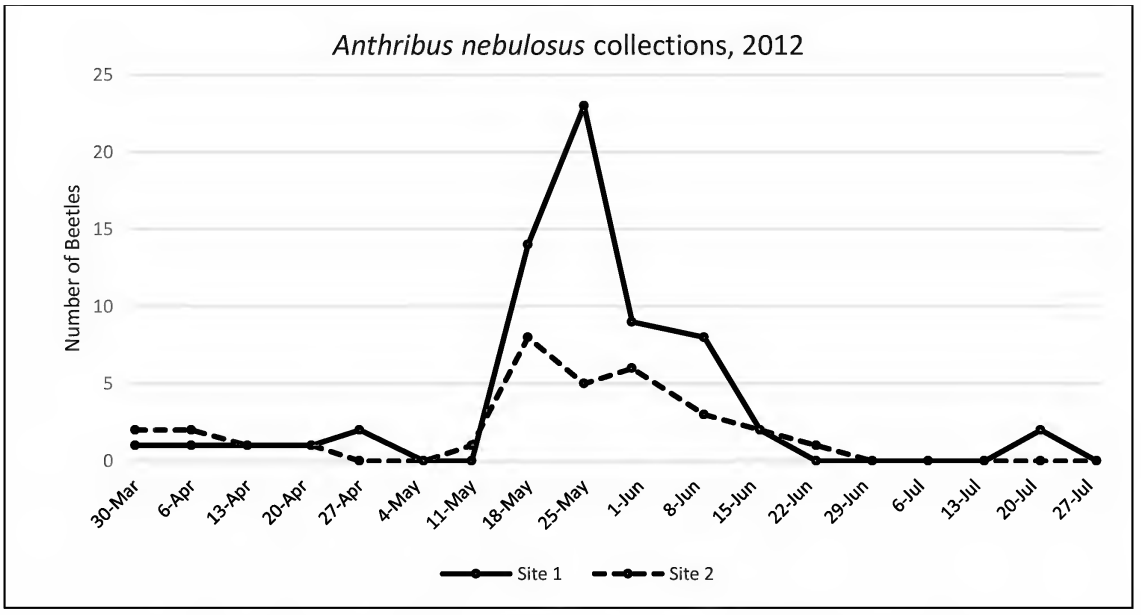

Fig. 2. *Anthribus nebulosus* adults collected from two sites in Virginia Beach, VA - 2012.

(36°53'36"N, 76°7'42"W), the surveys in 2011 and 2012 confirmed the establishment of *A. nebulosus* in previously unexplored locations in the cities of Virginia Beach, Norfolk, Chesapeake, and Portsmouth (Fig. 3). In 2013, surveying failed to confirm establishment in Hampton, Petersburg, and Richmond, and south into North Carolina. Aside from our submissions from Virginia Beach, no other *A. nebulosus* were found in the Virginia Tech or the Virginia Museum of Natural History collections (T. Dellinger, K. Ivanov, pers. comm.). Our collective data suggest that *A. nebulosus* has spread from the initial release location approximately 23 km west in Norfolk, 27 km south in Virginia Beach, 31 km southwest in Chesapeake, and 32 km west in Portsmouth. A geographical barrier was noted between the positive and negative sites. Locations separated from the positive sites by large bodies of water or swampland were negative for *A. nebulosus*. Our survey found a preference for hosts in managed landscapes of urban and suburban areas where willow oak was a common street tree and large infestations of oak lecanium were present. Trees in these habitats were ideal sampling sites for recovery of *A. nebulosus*. This anthribid similarly was found in managed landscapes (cemeteries, college campuses) in northeastern states (Hoebeke & Wheeler, 1991).

Our study provides evidence of the establishment and spread of *A. nebulosus* over four cities in southeastern Virginia since its release in 1981. Its presence adds to the beneficial insect complex previously reported (Schultz, 1984; Robayo Camacho, 2015) that suppresses outbreaks of oak lecanium in urban landscapes. We note images labeled as *A. nebulosus* from Philadelphia, Lancaster, and Juniata counties, PA and Montgomery County, MD (http://bugguide.net/node/view/278376, http://bugguide.net/ node/view/1063638) were taken 2014-2016.

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Fig. 3. Dispersal map of *Anthribus nebulosus* in southeastern Virginia (initial 1981 release site is starred).

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Arnold Ortmann's Little-known 1925-26 Mollusk Collecting Trips to Virginia

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ABSTRACT

Arnold Ortmann, Curator of Invertebrate Zoology at Carnegie Museum of Natural History in Pittsburgh, Pennsylvania during the early 20th century, and the foremost American freshwater malacologist of his time, made important contributions to the study of mollusks in Virginia, especially freshwater mussels. His final collecting trips to the Commonwealth occurred during the fall of 1925 and 1926, but he died in January 1927 and never published the results of these surveys. This paper includes a reconstruction of Ortmann's itinerary based on voucher specimen records and a summary of his collecting results for all mollusks obtained during these trips to eastern and southcentral Virginia. Several of the freshwater mussel species collected by Ortmann are now rare and declining, and no longer inhabit the areas where he documented them.

Key words: freshwater mussels, malacology, snails, unionids.

INTRODUCTION

Arnold Edward Ortmann (1863-1927; Fig. 1) is an important figure in the history of malacology in North America, including Virginia. He was widely recognized as the leading American authority of his time on the classification and morphology of freshwater mussels (Pilsbry, 1927). He can be regarded as the father of modern freshwater mussel ecology because of his extensive field surveys and detailed studies of their anatomy (especially gill structure) and reproduction (Haig, 2012).

A native of Prussia (Germany), Ortmann obtained his Ph.D. in 1885 from the University of Jena. Nine years later he immigrated to the United States and subsequently became a naturalized citizen in 1900. Starting in 1894, Ortmann served as Curator of Invertebrate Paleontology at Princeton University. In 1903, he accepted the position of Curator of Invertebrate Zoology at Carnegie Museum of Natural History in Pittsburgh, Pennsylvania, less than a decade after the museum's founding in 1895. He remained in this position until his sudden death on 3 January 1927 at the age of 64 (Holland, 1927). Ortmann was also on the faculty of the University of Pittsburgh, which conferred the honorary degree of Sc.D. upon him in 1911. According to Holland (1927), "As a field investigator [Ortmann] was scrupulously exact and untiring. As a student in the laboratory he was painstakingly industrious and most scrupulous in keeping his records above reproach." Pilsbry (1927) stated "His enthusiasm for natural history was contagious, and contributed largely to his success as a teacher. He possessed the ability in an unusual degree of concentrating all of his powers on the subject in hand. In the field he was indefatigable, never sparing himself, deterred by neither exposure or fatigue in the quest of specimens for his researches."

During his tenure at Carnegie Museum of Natural History (hereafter CM), Arnold Ortmann conducted extensive field studies of crayfish and freshwater mussels (unionids), and was particularly interested in the biogeography of the fauna of eastern United States (Ortmann, 1902, 1912, 1913). He produced several major papers on the crayfishes of Pennsylvania (Ortmann, 1905, 1906) before shifting his research

Fig. 1. Portrait of Arnold Edward Ortmann (photographer and date unknown but probably ca. 1920).

focus to freshwater mussels. He published extensively on the latter group, including a major monograph on the Pennsylvania fauna (Ortmann, 1911, 1919), distributional studies of mussels in various river drainages in eastern United States (e.g., Ortmann, 1918, 1924a, 1925, 1926), and numerous studies on the systematics, morphology, reproductive biology, and ecology of unionids (e.g., Ortmann, 1909a, 1920, 1923). He also published on mussels obtained by members of a collecting expedition to the Amazon basin in South America (Ortmann, 1921). Ortmann was one of the first biologists to discuss the effects of pollution on unionid populations (Ortmann, 1909b). He also lamented the loss of diverse riverine mussel communities to impoundment for hydroelectric dams (Ortmann, 1924b).

ARNOLD ORTMANN'S VIRGINIA FIELD WORK PRIOR TO 1925

During the last two decades of his life, Arnold Ortmann conducted field surveys for freshwater mussels throughout eastern United States, ranging from New England to Mississippi and west to the Ohio River drainage (Holland, 1927). He stressed the importance of gathering extensive amounts of distributional data before formulating biogeographic hypotheses (van der Schalie, 1951a, b; Haig, 2012). His classic review of the diverse unionid fauna of the Tennessee River system included 20 sites in southwestern Virginia that he personally sampled between 1912 and 1915, as well as material collected by others (Ortmann, 1918). These data serve as the oldest baseline for comparison to more recent surveys of a currently impoverished and imperiled fauna (e.g., Ahlstedt, 1991; Wolcott & Neves, 1994; Henley et al., 1999; Jones et al., 2014).

In 1911-1912, Ortmann surveyed for unionids at three sites in the upper part of the Roanoke River system in Virginia: Mason Creek, Salem, 13 August 1911; Tinker Creek, Roanoke and Roanoke River, Salem, both 10 June 1912 (CM collection data). His surveys disclosed a depauperate fauna consisting of only three species – *Elliptio complanata* (Eastern Elliptio), *Strophitus undulatus* (Creeper), and *Villosa constricta* (Notched Rainbow) (Ortmann, 1913). Of these species, Ortmann collected more *V. constricta* than the other two (CM collection data). During these same two years, especially 1912 when he sampled at 22 additional sites over 19 days between May and September (CM collection data), Ortmann surveyed for unionids throughout Virginia, including sites in the Potomac (Shenandoah), Rappahannock, James (upper), New, and Tennessee River drainages. His findings are included in two major faunal papers (Ortmann, 1918, 1919). Like the Tennessee River system, the mussel faunas of these other drainages have declined since Ortmann's time, especially that of the Shenandoah River (Chazal & Roble, 2011).

During the fall of 1925 and 1926, the final two field seasons of his life, Arnold Ortmann returned to Virginia to survey for freshwater mussels in eastern and southcentral areas of the Commonwealth. The details of these surveys were not published due to his untimely death and thus are not widely known. The purpose of this paper is to summarize the results of Ortmann's final surveys for mollusks, especially unionids, in Virginia based on existing voucher specimens. Apparently neither Johnson (1970) nor Clarke (1981, 1985) examined Ortmann's 1925-26 CM material as part of their reviews, although both cited his faunal survey papers. However, Johnson did report several unionids from three of the same localities visited by Ortmann on the basis of earlier work by others, plus one unattributed Ortmann record (see below).

MATERIALS AND METHODS

The data presented in this paper are based primarily on CM voucher material collected by Arnold Ortmann in Virginia during 1925-26, consisting of 197 unionids

(187 bivalves and 10 single valves; Figs. 2-3) and 634 snails (gastropods). The latter portion includes 535 specimens of freshwater snails, 98 land snails, and one slug. I only examined the unionid portion (the primary focus of Ortmann's surveys) of his Virginia collections from both years, and relied on the CM database for all gastropod records. Additional material from Ortmann's collecting trips to Virginia during 1925-26 is deposited in the University of Michigan Museum of Zoology in Ann Arbor, Michigan (UMMZ: 7 unionids, 120 freshwater snails). I did not examine any material in the University of Michigan collection, but that institution has made its voucher specimen data available online (UMMZ, 2016), from which I extracted Ortmann's Virginia records.

Fig. 2. Arnold Ortmann's original label and corresponding specimens (CM 61.12189) of *Lasmigona subviridis* collected on 22 August 1925 from the James River, Richmond, Virginia. Photos by the author.

Fig. 3. Representative specimens of *Fusconaia masoni* (= *Lexingtonia subplana*) collected by Arnold Ortmann in Virginia (top: CM 61.12344, ♀, 15 August 1926, James River, Manchester, City of Richmond; bottom: CM 61.12345, ♂, 18 August 1926, Swift Creek, Swift Creek Factory, Chesterfield Co.). Photos by Anne C. Chazal.

The database records of both CM and UMMZ had some missing or erroneous data that was reconcilable by comparing it with data associated with the records of other species from the same localities and dates, data from the other museum, or my personal knowledge of Virginia geography. I also searched the online databases of the Academy of Natural Sciences at Drexel University (ANSP, 2016), Illinois Natural History Survey (INHS, 2016), Museum of Comparative Zoology, Harvard University (MCZ, 2016), and the United States National Museum of Natural History (USNM, 2016) for relevant Ortmann records (i.e., 1925-26 only), but found none. Common names used in the text follow Turgeon et al. (1998).

I used ArcGIS10 software (® Esri, Redlands, CA) and georeferenced 1:24,000 scale U.S. Geological Survey topographic maps and recent aerial photographs to plot the actual or approximate locations of Ortmann's sampling sites by determining the proximity of his site names and descriptions, streams or rivers, and historic or extant railroad grades. Some of Ortmann's labels contained more detailed locality information than others, thus requiring variable amounts of effort on my part to determine their actual or approximate locations. I was unable to locate one site name that appears on his labels ("Elk Creek, Bells" in Bedford County, which possibly refers to the village of Bellevue), so estimated its possible location along Elk Creek.

ARNOLD ORTMANN'S FIELD ITINERARY DURING 1925-1926

Arnold Ortmann presumably traveled via train from Pittsburgh, Pennsylvania to Virginia, and again primarily by train while in the latter state. Nearly all of his collecting sites appear to correspond to railroad crossings of rivers and streams, sometimes at a considerable distance from the nearest human settlement, perhaps suggesting that he disembarked from the train almost directly at the collecting site. Alternatively, Hoffman (1996) postulated that Ortmann hired a wagon for transport from local railroad depots to his rural collecting sites.

More than half of Ortmann's survey sites lie in a north-south orientation along extant or historic railroad grades extending from Fredericksburg south to Emporia (Fig. 4). Most of his remaining sampling sites follow other railroad routes in a roughly east-west orientation, with southward extensions to Danville and Martins-

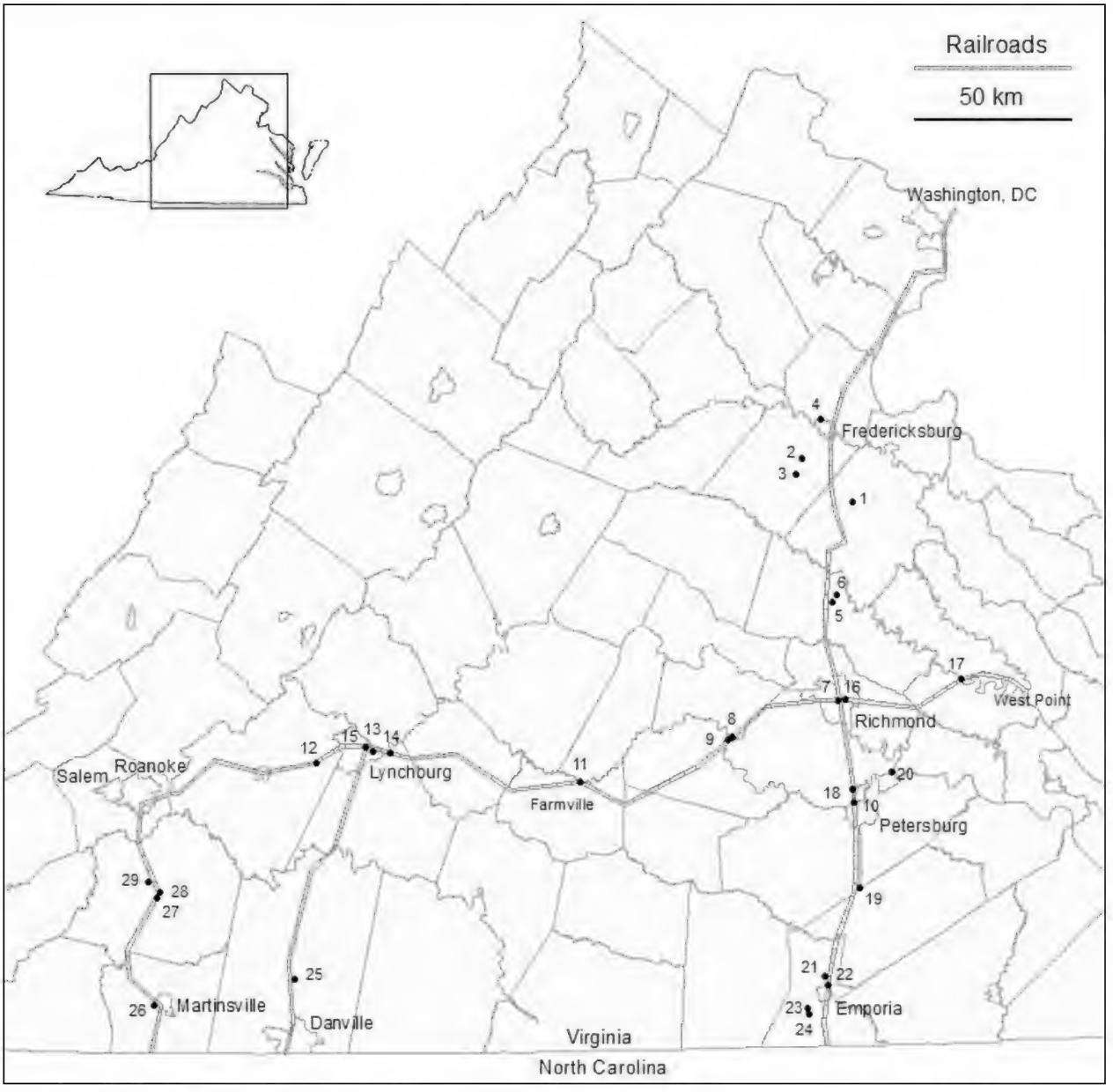

Fig. 4. Map of Arnold Ortmann's mollusk sampling sites in Virginia during 1925-26. Numbered dots correspond to locality descriptions in Table 1. Sites 1-15 were surveyed in 1925 and sites 13, 15-29 in 1926.

Table 1. Itinerary of Arnold Ortmann's mollusk collecting trips to Virginia in the fall of 1925 and 1926 as reconstructed from Carnegie Museum of Natural History (CM) voucher specimen data. The exact order of multiple surveys on a given day is unknown. County names in brackets appear on Ortmann's original labels and in the CM database, but they are not currently applicable to the respective independent cities. A total of 31 collections was made at 29 sites (26 aquatic, 3 terrestrial).

Site[1]	1925	
	August	
1	17	Mattaponi River, Woodford, Caroline Co.
2	18	Ni River, Spotsylvania, Spotsylvania Co.
3	18	Po River, Spotsylvania, Spotsylvania Co.
4	19	Rappahannock River, 4 miles upstream of Fredericksburg, Spotsylvania Co.
5	21	South Anna River, Ashland Mill, Hanover Co.
6	21	Little River, Taylorsville, Hanover Co.
7	22	James River, Richmond (city) [Henrico Co.]
8	24[2]	Pilkinton, Powhatan Co.
9	24	Appomattox River, Mattoax, Amelia Co.
10	26	Appomattox River, Petersburg (city) [Dinwiddie Co.]
11	27	Appomattox River, Farmville, Prince Edward Co.
12	29[3]	Elk Creek, Bells, Bedford Co.
13	30-31	James River opposite Lynchburg, Amherst Co.
14	31[3]	James River, Six-Mile Bridge, Campbell Co.
	September	
15	2[2]	Lynchburg (city) [Campbell Co.]
Site	1926	
	August	
16	15	James River (branch), Manchester, Richmond (city) [Chesterfield Co.]
17	16	Pamunkey River, White House, New Kent Co. (tidal)
18	18	Swift Creek, Swift Creek Factory, Chesterfield Co.
19	19	Rowanty Creek, Malone Bridge, Dinwiddie Co.
20	20	James River, City Point, Hopewell (city) [Prince George Co.] (Appomattox River confluence; tidal)
21	22	Three Creek, Slagle's Mill, Greensville Co.
22	22	Three Creek, North Emporia, Greensville Co.
23	22	Fontaine Creek, Round Hill Church near Emporia, Greensville Co.
24	22	Fontaine Creek, Rockbridge School near Emporia, Greensville Co.
25	31[4]	Dry Fork, Banister River, Pittsylvania Co.
	September	
26	2[3]	Smith River, Martinsville (city) [Henry Co.]
27	3[3]	Pigg River, Rocky Mount, Franklin Co.
28	3[2]	Rocky Mount, Grassy Hill, Franklin Co.
29	3[3]	Blackwater River, Gogginsville, Franklin Co.
13	5[3]	James River [probably opposite Lynchburg], Amherst Co.
15	6[2]	Lynchburg (city) [Campbell Co.]

[1]Site numbers correspond to the points in Figure 4.

[2]Terrestrial sampling site (only land snails were collected).

[3]Aquatic mollusk collections were limited to snails.

[4]No collector is recorded for the lone mollusk specimen (CM 70897, *Elliptio complanata*) obtained at Dry Fork, but Ortmann is the probable candidate.

ville, but all but one (Lynchburg-Danville) of these lines are now used exclusively by freight trains, passenger service to cities and towns such as Farmville, Rocky Mount, and Martinsville having been discontinued decades ago. Modern passenger rail service to Lynchburg is via a different route (north-south) than that presumably used by Ortmann (east-west).

At least two of the localities mentioned on Ortmann's collecting labels no longer exist (i.e., Rockbridge School and Swift Creek Factory). This is also true of at least one of the railroad lines, namely the Seaboard Air Line Railroad that crossed Swift Creek at Swift Creek Factory (Chesterfield County, 1926) in southeastern Chesterfield County, approximately 10 km upstream of the confluence with the Appomattox River. This line was discontinued and removed long ago, but remnants of the railroad bridge (N37.2711 W77.4199) remain immediately upstream of a small hydroelectric dam on (the lowermost) Swift Creek Lake and are clearly visible on recent aerial photographs. Ortmann's "Swift Creek Factory" probably refers to Mechanics Manufacturing Company or Union Manufacturing Company, which were established along Swift Creek in 1836 and 1837, respectively (O'Dell, 1983). The former factory was destroyed by a large fire in 1926 (Ortmann's survey was conducted on 18 August of that year) that also consumed the surrounding company town (Swift Creek Mill Village) inhabited by several dozen families (O'Dell, 1983). Some of Ortmann's Swift Creek labels provide more precise locality data, indicating his collection site was 0.5 miles below the factory at "Rolling Mills", which presumably refers to a metal rolling mill. This would apparently place his collection site approximately midway between the current hydroelectric dam and Swift Creek Mill Theatre, the latter now located on the site of a historic grist mill (ca. 1660; O'Dell, 1983) with an associated dam (extant) along U.S. Route 1 (historic Manchester-Petersburg Turnpike).

In the fall of 1925, Ortmann's field itinerary between 17 August and 2 September included 15 sampling sites (13 aquatic, 2 terrestrial) in the eastern portion of the state (Table 1). Half of the aquatic sites were along the Appomattox and James rivers. He returned to Virginia during August and September of the following year and sampled at 16 sites (14 aquatic, 2 terrestrial) ranging as far west as the Smith River at Martinsville (Table 1; Fig. 3). Ortmann extended his collecting efforts south into North Carolina and Tennessee during the last week of August 1926 before returning to Virginia to complete his work in the Commonwealth. In both years, he collected aquatic mollusks from the James River in Amherst County ("opposite Lynchburg" is specified on 1925 specimen records but not 1926, although it seems probable that he sampled at the same site in both years because of the location of a railroad crossing).

RESULTS

Arnold Ortmann's malacological collections made during his 1925-26 trips to Virginia include 13 species of unionids (Table 2), eight species of freshwater gastropods (Table 3), and 11 species of land snails and slugs (Table 4). He collected 0-8 species of mussels and 0-4 species of freshwater snails per aquatic sampling site. Swift Creek at Swift Creek Factory in Chesterfield County yielded the most species of unionids and the Appomattox River at Farmville had the highest freshwater snail diversity, as judged by voucher specimen material in CM and UMMZ.

Eastern Elliptio (*Elliptio complanata*) was both the most frequently encountered and most common unionid (46% of all specimens) during Ortmann's surveys, occurring at 15 of the 21 sites (71%) where he collected mussels (Table 2; Fig. 5). This species remains the most ubiquitous unionid in the Atlantic Slope drainage of Virginia (pers. obs.). Johnson (1970) stated that *E. complanata* is generally the most common mussel throughout its range, and it is sometimes the only species found at a given locality. Ortmann recorded three other unionids (*Elliptio producta* [Atlantic Spike], *Pyganodon cataracta* [Eastern Floater], and *Strophitus undulatus*) at six sites each, with the remaining nine species found at 1-5 sites (Table 2: Figs. 5-7).

Ortmann collected freshwater snails at 20 of his 26 aquatic sampling sites in eastern and southcentral Virginia (Table 3), including all five sites where unionids were not collected (and thus presumably not found). *Leptoxis* (= *Anculosa*) *carinata* (Crested Mustalia, 12 sites) and *Elimia virginica* (Piedmont Elimia, 11 sites) were by far the most frequently encountered freshwater gastropods as judged by voucher specimen material in CM and UMMZ. The former species is the most commonly encountered snail in the Atlantic Slope drainage of Virginia (FGNA, 2016; pers. obs.). Ortmann (1913) noted that *E. virginica* is common and widespread in the mid-Atlantic region, being "found practically everywhere, possibly with the exception of the smallest streams in the headwaters." This statement remains largely true to this day.

Land snails were clearly not the focus of Ortmann's surveys. Nearly all of his specimens (91 of 99) were obtained during visits he made on 2 September 1925 and 6 September 1926 to one or more unspecific sites in the City of Lynchburg (Table 4). The remaining eight

Table 2. Summary of Arnold Ortmann's freshwater mussel collections in Virginia during 1925-26. Unbracketed figures are the number of specimens (whole or partial) deposited in Carnegie Museum of Natural History (CM) and bracketed figures are the corresponding number in the University of Michigan Museum of Zoology (UMMZ).

Watershed County/city	Locality	No. of unionid species	*Alasmidonta heterodon*	*Alasmidonta undulata*	*Elliptio complanata*	*Elliptio lanceolata*	*Elliptio producta*	*Fusconaia masoni* [1]	*Lampsilis cariosa*	*Lampsilis radiata*	*Lasmigona subviridis*	*Leptodea ochracea*	*Pyganodon cataracta*	*Strophitus undulatus*	*Villosa constricta*
Rappahannock															
Spotsylvania	Rappahannock River, 4 miles upstream of Fredericksburg	4			10	1	1				1				
York															
Spotsylvania	Ni River, Spotsylvania	2	1		4										
Spotsylvania	Po River, Spotsylvania	3			4	3								1	
Caroline	Mattaponi River, Woodford	3			7					1			1		
Hanover	South Anna River, Ashland Mill	2			2	1									
Hanover	Little River, Taylorsville	1			4										
New Kent	Pamunkey River, White House (tidal)	3								11		2	1		
James															
Richmond (city)	James River, Richmond	5			5			1	1		2		1		
Richmond (city)	James River (branch), Manchester	3			4			1						4	
Hopewell (city)	James River, City Point (tidal)	2			2								8		
Campbell	James River, Six-Mile Bridge	0													
Amherst	James River opposite Lynchburg	5			16		4 [2]				4			2	4
Petersburg (city)	Appomattox River, Petersburg	4			21		4	1			12 [3]				
Amelia	Appomattox River, Mattoax	1			4										
Prince Edward	Appomattox River, Farmville	1			1										
Chesterfield	Swift Creek, Swift Creek Factory	8		1	7 [2]		1	4		2	1	2		1	
Bedford	Elk Creek, Bells	0													
Chowan															
Dinwiddie	Rowanty Creek, Malone Bridge	2					2								2
Greensville	Three Creek, Slagle's Mill	1											5		
Greensville	Three Creek, North Emporia	3					3						4	1	
Greensville	Fontaine Creek, Round Hill Church	1													1
Greensville	Fontaine Creek, Rockbridge School	1												1	
Roanoke															
Franklin	Pigg River, Rocky Mount	0													
Franklin	Blackwater River, Gogginsville	0													
Martinsville (city)	Smith River, Martinsville	0													
Pittsylvania	Dry Fork, Banister River	1			1										
Total sites (26)			1	1	15	3	6	4	1	3	5	2	6	6	3
Total specimens (204)			1	1	94	5	17	7	1	14	23	4	20	10	7

[1]All specimens were identified by Ortmann (and are currently catalogued) as *Lexingtonia subplana*, which is regarded as a junior synonym of *Fusconaia masoni* by most contemporary malacologists.

Table 3. Summary of Arnold Ortmann's freshwater snail collections in Virginia during 1925-26 as based on Carnegie Museum of Natural History (CM) and University of Michigan Museum of Zoology (UMMZ) voucher specimens.

Watershed County/city	Locality	Number of snail species	*Campeloma decisium*	*Elimia catenaria* [1]	*Elimiia virginica*	*Leptoxis carinata*	*Helisoma anceps*	*Planorbella trivolvis*	*Physa acuta*	*Physa gyrina*
Rappahannock										
Spotsylvania	Rappahannock River, 4 miles upstream of Fredericksburg	2			X	X				
York										
Spotsylvania	Ni River, Spotsylvania	0								
Spotsylvania	Po River, Spotsylvania	2	X				X			
Caroline	Mattaponi River, Woodford	1			X					
Hanover	South Anna River, Ashland Mill	1			X					
Hanover	Little River, Taylorsville	1			X					
New Kent	Pamunkey River, White House (tidal)	0								
James										
Richmond (city)	James River, Richmond	3			X	X			X	
Richmond (city)	James River (branch), Manchester	2			X	X				
Hopewell (city)	James River, City Point (tidal)	0								
Campbell	James River, Six-Mile Bridge	2			X	X				
Amherst	James River opposite Lynchburg	2			X	X				
Petersburg (city)	Appomattox River, Petersburg	3	X		X	X				
Amelia	Appomattox River, Mattoax	2				X				X
Prince Edward	Appomattox River, Farmville	4	X			X	X			X
Chesterfield	Swift Creek, Swift Creek Factory	1				X				
Bedford	Elk Creek, Bells	1							X	
Chowan										
Dinwiddie	Rowanty Creek, Malone Bridge	0								
Greensville	Three Creek, Slagle's Mill	1						X		
Greensville	Three Creek, North Emporia	0								
Greensville	Fontaine Creek, Round Hill Church	2		X	X					
Greensville	Fontaine Creek, Rockbridge School	2		X	X					
Roanoke										
Franklin	Pigg River, Rocky Mount	1				X				
Franklin	Blackwater River, Gogginsville	1				X				
Martinsville (city)	Smith River, Martinsville	1				X				
Pittsylvania	Dry Fork, Banister River	0								
Total (26 sites)			3	2	11	12	2	1	2	2

[1] CM specimens are catalogued as *Elimia catenaria* and UMMZ specimens as *E. cancellata dislocata*. Goodrich (1942) first reported the Greensville County, Virginia populations under the name *Goniobasis catenaria dislocata*. Turgeon et al. (1998) elevated *E. dislocata* to full species status (common name Lapped Elimia) but without supporting justification.

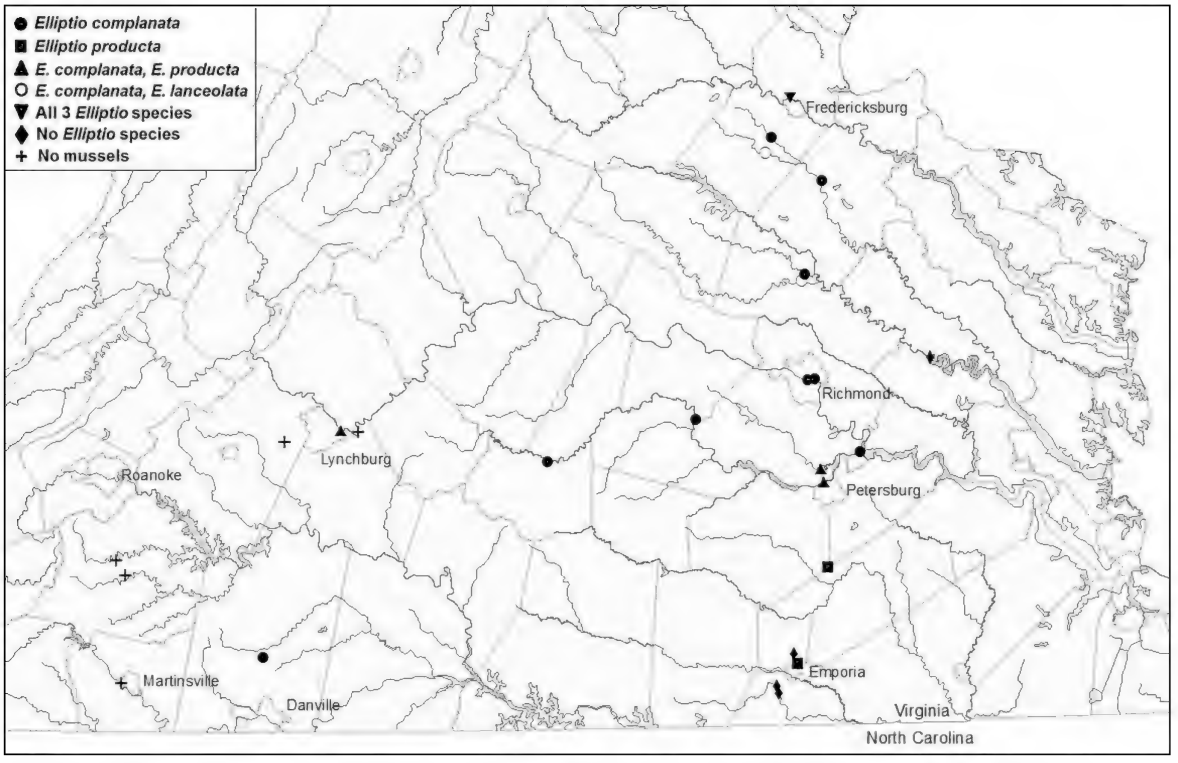

Fig. 5. Sampling locations where Arnold Ortmann collected *Elliptio* species in Virginia during 1925-26. The reservoirs shown on this and the following maps did not exist at that time.

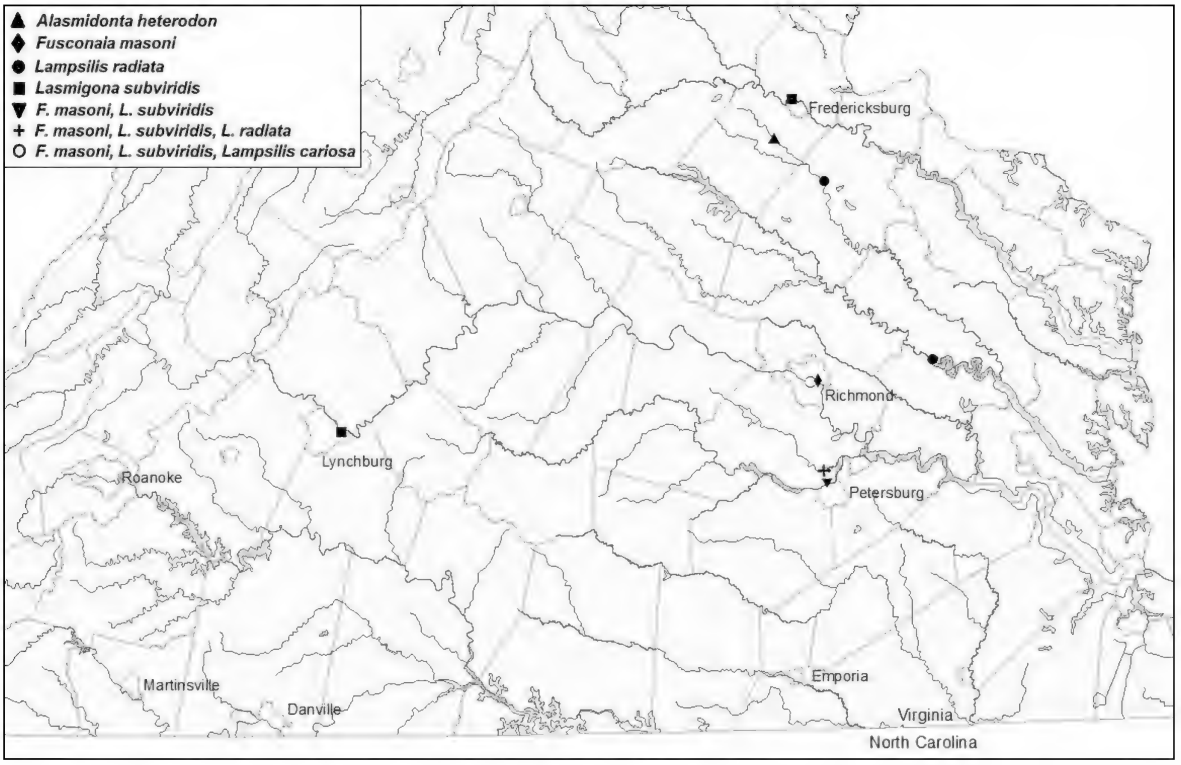

Fig. 6. Sampling locations where Arnold Ortmann collected *Alasmidonta heterodon*, *Fusconaia masoni* (= *Lexingtonia subplana*), *Lampsilis cariosa*, *Lampsilis radiata*, and *Lasmigona subviridis* in Virginia during 1925-26.

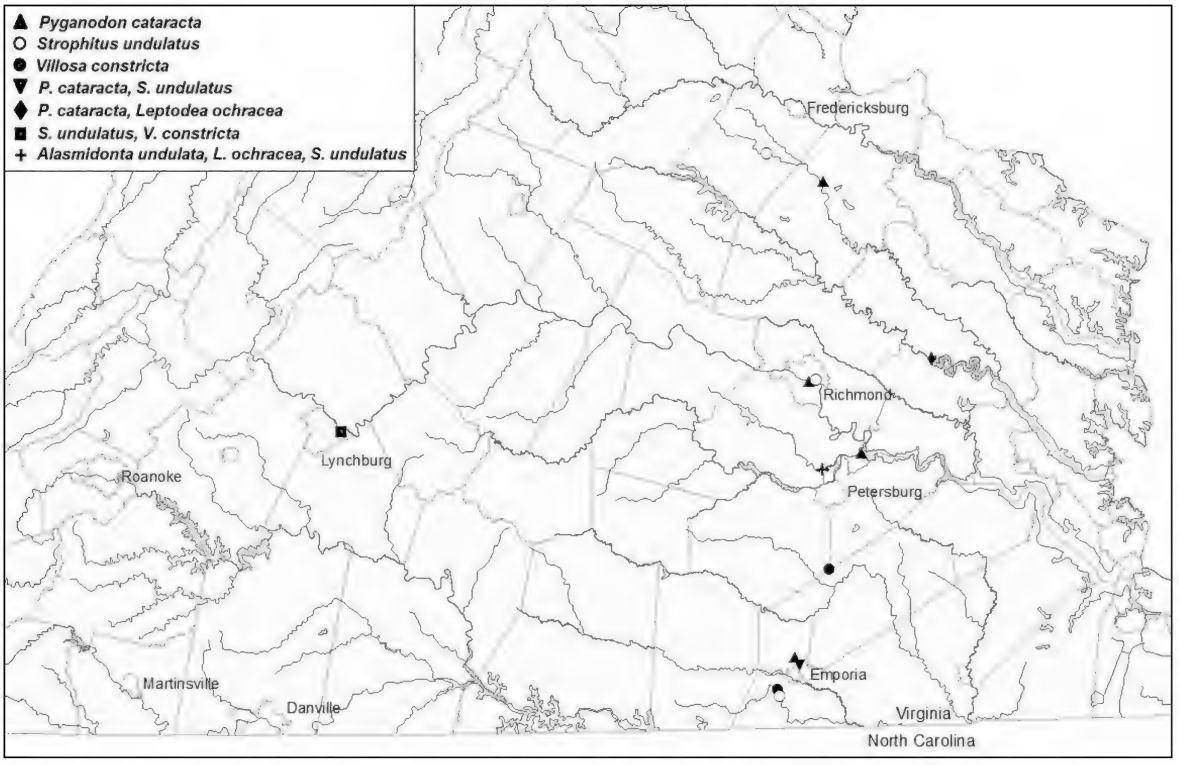

Fig. 7. Sampling locations where Arnold Ortmann collected *Alasmidonta undulata*, *Leptodea ochracea*, *Pyganodon cataracta*, *Strophitus undulatus*, and *Villosa constricta* in Virginia during 1925-26.

land snails, including three taken at primarily aquatic sampling sites, likely were obtained incidentally. Ortmann collected a total of only five land snails at two of the three sites (Pilkinton and Grassy Hill) that I categorized as terrestrial sampling sites in Table 1.

DISCUSSION

Arnold Ortmann's 1925-26 collections from eastern and southcentral Virginia were among the first made in this region and thus provide some degree of baseline data for comparison to subsequent surveys. Several of the unionid species documented by Ortmann are now of high conservation concern, including *Alasmidonta heterodon* (Dwarf Wedgemussel; federal and state endangered), *Fusconaia masoni* (= *Lexingtonia subplana*) (Atlantic Pigtoe; state threatened), and *Lasmigona subviridis* (Green Floater; state threatened). In addition, populations of *Elliptio lanceolata* (Yellow Lance), *Lampsilis cariosa* (Yellow Lampmussel), and *L. radiata* (Eastern Lampmussel) are declining and all are now rare to uncommon in the state. Both the Atlantic Pigtoe and Yellow Lance are currently under review by the U.S. Fish and Wildlife Service for possible federal listing.

Table 4. Summary of Arnold Ortmann's terrestrial snail collections in Virginia during 1925-26 as based on Carnegie Museum of Natural History voucher specimens.

Family	Species	Pilkinton, Powhatan Co.	Lynchburg (city) [1]	Grassy Hill, Rocky Mount, Franklin Co.	James River [opposite Lynchburg], Amherst Co.	Rockbridge School near Emporia, Greensville Co.
Gastrodontidae	*Ventridens intertextus*				1	
Gastrodontidae	*Ventridens ligera*		31			
Gastrodontidae	*Zonitoides arboreus*	1				
Haplotrematidae	*Haplotrema concavum*			1		
Helicidae	*Cepaea nemoralis* [2]		31			
Philomycidae	*Philomycus carolinianus*	1				
Polygyridae	*Euchemotrema fraternum*			1		
Polygyridae	*Mesodon thyroidus*		4			
Polygyridae	*Neohelix albolabris*		13		2	1
Polygyridae	*Patera appressa*		11			
Polygyridae	*Triodopsis juxtidens*		1			
Total specimens		2	91	2	3	1

[1] Combined number of specimens collected on 2 September 1925 and 6 September 1926.
[2] Introduced species.

The Dwarf Wedgemussel was thought to have been extirpated from Virginia prior to 1990 but it was rediscovered at two sites in the Commonwealth that year (Neves, 1991). Several additional populations have since been found in eastern Virginia (Bruenderman & Stevenson, 1995; Michaelson & Neves, 1995; Strayer et al., 1996). Ortmann documented *A. heterodon* only in the Ni River during his 1925-26 surveys (Table 2). He had previously found this species in Mountain Run (Culpeper Co.) and Marsh Run (Fauquier Co.) (Ortmann, 1919), both in the Rappahannock River drainage, but these two populations are now believed to be extirpated.

Prior to this paper, the Green Floater was reported from three of the five sites where Ortmann found it, including Richmond (a lone specimen collected by Major John LeConte, presumably from the James River, was described by Isaac Lea [1845, 1853] as the new species *Unio hyalinus* [USNM 86131, holotype], now regarded as a junior synonym of *L. subviridis* [Johnson, 1970]), Fredericksburg (an unspecified number of specimens collected by a "Dr. Emmons," presumably from the Rappahannock River, were reported by Lea [1874] under the name *Unio insolidus*, now regarded as a junior synonym of *Lasmigona decorata* [Carolina Heelsplitter], a close relative of *L. subviridis* restricted to the Carolinas [Clarke, 1985]), and the Appomattox River at Petersburg (Johnson, 1970; Clarke, 1985). In addition, W. J. Farrer, a mollusk collector in the early 20th century, collected three *L. subviridis* from the James River at Richmond (UMMZ 104150; collection date unknown) and two more from the Rappahannock River (UMMZ 104161; exact location and collection date unknown). Clarke (1985) previously listed Farrer's UMMZ records but without citing the actual collector. Johnson (1970) and Clarke (1985) both noted the existence of UMMZ specimens of *L. subviridis* from the Appomattox River at Petersburg, but neither author provided further details. My online search of records in this collection revealed that three specimens (UMMZ 62309) were collected by Arnold Ortmann at this locality on 26 August 1925, along with a dozen more deposited in the Carnegie Museum (CM 61.12190, "abundant below dam along rocks"). Ortmann (1919) had previously recorded *L. subviridis* from the Rappahannock River at Remington (Fauquier Co.), which is more than 50 km upstream from his 19 August 1925 collecting site near Fredericksburg.

There are no recent records of *L. subviridis* or *F. masoni* from the lower Appomattox River or its tributary Swift Creek (Gerberich, 1991; Kitchel, 1991; VDCR, 2016), sites where Ortmann recorded both species during 1925-26. Furthermore, *F. masoni* was apparently last documented in the Richmond section of the James River by Ortmann during these trips (VDCR, 2016). Although *L. subviridis* evidently no longer occurs at the sites where Ortmann documented it during his last surveys, this species has been found farther upstream in both the James and Rappahannock rivers during the past two decades (VDCR, 2016; pers. obs.).

Swift Creek, which spans approximately 65 km almost entirely within Chesterfield County, has changed much since Ortmann's 1926 survey yielded eight species of unionids. Since the 1930s, three new impoundments (Swift Creek Lake [two with this name] and Swift Creek Reservoir [largest at 688 ha; formed in 1965]) have been created, the latter currently serving as a public water supply. The lowermost Swift Creek Lake (17 ha), alternately known as Lakeview Reservoir, originally served as a public water supply, but it is now used for recreation and hydroelectric power generation. In addition to the impacts of dam creation, the entire Swift Creek watershed has become significantly more urbanized, especially during the past half century, due to its proximity to the cities of Richmond and Petersburg. This has contributed to reduced water quality for unionids and other aquatic organisms. Portions of Swift Creek are currently included on the "impaired waters list" prepared biennially by the Virginia Department of Environmental Quality due to high counts of the bacterium *Escherichia coli* (VDEQ, 2016).

Given that the primary purpose of Ortmann's surveys of 1925-26 was to document the unionid fauna of selected streams and rivers in eastern and southcentral Virginia, it is not surprising that his presumably incidental collections of freshwater and terrestrial gastropods consist mostly of rather conspicuous, medium to large, wide-ranging species. None of the freshwater snails collected during Ortmann's surveys are currently of high conservation concern, although *Elimia catenaria* (Gravel Elimia) reaches its northern range limit in southeastern Virginia (Hoffman, 1996). Goodrich (1942) first reported this species (as *Goniobasis catenaria dislocata*) from Virginia from "Green[s]ville County," but he did not provide further details. Hoffman (1996) clarified the original source of this record (Ortmann's 1926 collections; Table 3) and added newer collection records for the Chowan and Roanoke River drainages of Virginia. He stated that *E. catenaria* "is widespread and often abundant in many streams of 'Southside Virginia.' " Among Ortmann's small collection of land snails, *Ventridens ligera* (Globose Dome) and the exotic *Cepaea nemoralis* (Grovesnail) each account for nearly one-third of the total specimens, with only two

other species represented by more than 10 specimens (Table 4).

The contributions of Arnold Ortmann to the study of malacology in Virginia are a valuable component of the history of natural history in the Commonwealth. The importance of natural history museums in preserving voucher specimens and associated data are borne out in this paper, which would not have been possible without these sources of information.

ACKNOWLEDGEMENTS

I would like to especially thank Timothy A. Pearce of Carnegie Museum of Natural History for providing database records and access to the mollusk collection at that institution, for answering my questions about specific records and specimens subsequent to my visit, and for reviewing an earlier draft of the manuscript. Arthur E. Bogan (North Carolina Museum of Natural Sciences) also provided helpful comments on the manuscript. The efforts of the respective staffs of the Academy of Natural Sciences of Drexel University, Harvard University Museum of Comparative Zoology, Illinois Natural History Survey, University of Michigan Museum of Zoology, and United States National Museum of Natural History (Smithsonian Institution) to make their specimen records available online is gratefully acknowledged. Anne C. Chazal of the Virginia Department of Conservation and Recreation, Division of Natural Heritage, examined the Carnegie Museum mollusk collection with me and took photographs of selected specimens and collection labels. Patricia Roble and Liess VanderLinden-Brusse of the Chesterfield Historical Society of Virginia assisted with research of historical localities near Richmond. The late Richard L. Hoffman of the Virginia Museum of Natural History originally conceived of this paper more than a decade ago and had intended to write it himself. I hope he would have approved of this version.

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Miscellanea

Reports

1. President's Report

This issue of *Banisteria* will be my last opportunity to engage with you as president of the Virginia Natural History Society (VNHS). I have enjoyed my term of service for the Society and the interactions I have had with the men and women who have worked so well together. The combined efforts of these people have made the continued publication of *Banisteria* possible.

Banisteria is a unique hub for everyone interested in Virginia's natural resources and history. We had a very productive conversation about what types of articles are best suited for publication at our December 2016 board meeting. It allowed us to consider what are the differences between natural history and experimental science, the latter being the output of most scientific work. The VNHS fills a very important niche in the scientific literature by selecting submissions which remain true to an exploration of natural history in this region. Its all-inclusive coverage certainly reflects our eclectic interests about the geology and biota in Virginia and beyond.

Banisteria is also a place to give homage to the contributions made by individuals over the years. It is a comfort to know that one can discover or rekindle a connection with great women and men of science by researching past issues of *Banisteria*, both by reading their articles and retrospectives written in their honor. Reading these can inspire all of us to make future contributions to the journal or less formally, to submit notes and features to the VNHS newsletter. Dr. Paul Marek is our contact for the newsletter. He looks forward to receiving material regarding recent studies, work in progress, areas of future investigation, upcoming events, and more.

I solicit everyone who has a passion for natural history to consider offering their time and talents for the VNHS. There are openings as committee members, councilors, and officers. I assure you that it will give you a great sense of accomplishment. Please send our next president, Dr. Alfred L. Gardner, a message about your willingness to be a part of VNHS and *Banisteria*. We look forward to working with you.

Respectfully submitted
Michael Lachance, President
Virginia Natural History Society

2. Secretary-Treasurer's Report

As of December 10, 2016, the society has 95 members, including 13 institutions. This is similar to last year's membership of 95 members and 14 institutions in December 2015. In previous years, 105-127 members had been recorded at this time of year. The current bank balance is $14,210.51, up from $13,408.44 in December 2015.

Respectfully submitted,
Rachel M. Goodman
Secretary/Treasurer

3. Webmaster's Report

Recent traffic on the society's website is summarized in the following table:

Month	Visits	Pages	Files	Hits
Dec-16	1777	3938	8147	13354
Nov-16	2237	3992	9097	13757
Oct-16	1716	3076	9809	13838
Sep-16	1491	2797	8854	12423
Aug-16	2501	4306	9411	14245
Jul-16	1150	2251	8011	11622

Respectfully submitted,
John White, Webmaster

4. Editor's Report

The lead article in this issue of *Banisteria* is our first paper with a citizen science component. It includes a call for assistance with the important project of digitizing herbarium specimens collected in Virginia. The last article (Historical Contributions section) illustrates how natural history collections can be used to obtain valuable, but previously unpublished data.

I am currently working on the first issue of *Banisteria* for 2017. More submissions are always needed for future issues of this journal because there is rarely a backlog of accepted manuscripts, so please consider submitting a paper, note, biography, or historical contribution

concerning the natural history of Virginia. Consult the recently revised Instructions for Authors in the back of this issue (also posted on the society's website) before preparing your paper. Effective immediately, reviews of new books relevant to Virginia or regional natural history should be sent to the society's newsletter editor, Paul Marek, at pmarek@vt.edu.

Respectfully submitted,
Steve Roble
Editor, *Banisteria*

Announcements

1. Dues renewal and election ballot

A membership renewal form and election ballot are enclosed with this issue of *Banisteria*. Please renew your membership for 2017 by returning the form and payment by check or money order. All members are encouraged to attempt to recruit at least one new member to our society. Faculty members may nominate up to 3 students for a free one-year membership in the society following the guidelines presented in the Student Membership Incentive paragraph on page 39.

Please cast your vote for Vice President (= President-Elect), Secretary-Treasurer, and Councilor by returning the enclosed ballot prior to the due date.

2. News of Members

Banisteria Associate Editor Tom Wieboldt, a founding member of the Virginia Natural History Society, retired at the end of September 2016 from his position as Curator of the Massey Herbarium in the Department of Biological Sciences at Virginia Tech after 35 years of service to the university. Tom reports that most of his time was devoted to vascular plants, and that portion of the collection grew from 67,000 specimens to 109,000 during his tenure. Fungi are also part of the herbarium's holdings, with bryophyte and lichen collections being added more recently. During the past decade, Tom helped move the herbarium into the modern era through database and digitization efforts, which are ongoing.

One of Tom's principal initiatives was to make the *Atlas of the Virginia Flora* available to a wider audience online, initially on servers at Virginia Tech but later moved to the website of Virginia Botanical Associates (http://vaplantatlas.org/).

We congratulate Tom on a stellar career and wish him the best in his future endeavors. We also thank him for agreeing to continue serving the Society as the Associate Editor for Botany for *Banisteria*.

John D. Glaser, a member of the Virginia Natural History Society during the past decade, recently passed away. He was a retired geologist for the state of Maryland who published numerous technical maps and reports, as well as several popular guides, concerning the geology of that state. John was also interested in entomology, particularly beetles (especially tiger beetles) and moths, and published several papers on the Maryland fauna. In 2007, he coauthored a paper on the moths of Turkey Run and Great Falls National Parks in northern Virginia that appeared in *Banisteria* 29: 17-31.

3. Recent publications of interest

Christopher M. Bailey, W. Cullen Sherwood, L. Scott Eaton, & David S. Powars (editors). 2016. Geology of Virginia. Special Publication No. 18, Virginia Museum of Natural History, Martinsville, VA. 538 pp. $35. (available for purchase exclusively from the museum's online store [http://www.vmnh.net/products/cats] or in the museum's gift shop.)

Research into Virginia's geology has been conducted for well over two hundred years, but this is the first comprehensive review of the subject published in over a century. This volume provides a modern overview of Virginia's geology and updates the geologic community on recent advances made in understanding Virginia's geologic history. It contains detailed summaries of the geological features of all regions of the Commonwealth. The 18 chapters represent the combined efforts of more than 40 geoscience professionals. Among the various chapter titles are those on the soils, hydrogeology, and fossil vertebrates of Virginia, as well as coal, oil and gas, and geoarcheology. This volume covers all aspects of regional, historical, economic, and hazards geology and is intended as a resource for professional geologists, graduate students, and upper-level undergraduates. Geologists unfamiliar with Virginia will be able to use this volume as a primer to the region.

Revised Society Bylaws

The amended bylaws of the Virginia Natural History Society as recently approved by the Executive Committee appear below following the society's Articles of Incorporation.

THE VIRGINIA NATURAL HISTORY SOCIETY
ARTICLES OF INCORPORATION AND BYLAWS

ARTICLES OF INCORPORATION

Article I. NAME
The society shall be called "The Virginia Natural History Society" (referred to hereinafter as "the Society").

Article II. OBJECTIVE
The objective of the Society shall be to promote the study of all aspects of the natural history of Virginia, to educate the citizens of the Commonwealth about natural history, and to conserve its natural resources.

Article III. The Society shall formulate bylaws to regulate its organization and procedures.

Article IV. The governing body of the Society shall be the Executive Committee.

Article V. The Society is organized for scientific, educational, and charitable purposes as defined under the appropriate sections of the Internal Revenue Code. The Executive Committee is empowered to make appropriate changes to retain the tax-exempt status of the Society. Any such changes require a majority vote of the Executive Committee.

BYLAWS

Article I. MEMBERSHIP

Section 1. Anyone who is interested in the objective of the Society is eligible for membership. Membership can be attained by application to the Secretary-Treasurer.

Section 2. The classes of membership shall be Regular, Student, Family, Institutional, Supporting, Patron, Benefactor, Life, and Honorary. Student members must be currently enrolled as graduate, undergraduate, or high school students. A letter from their school verifying their student status must be included with the application for membership. Annual dues for these classes of membership shall be set by the Executive Committee and adjusted as needed. Honorary Councilors pay no dues.

Section 3. Honorary Councilors shall be nominated by the Executive Committee and voted upon at the Executive Committee Meeting. Additional nominations may be made from the floor. Honorary Councilors shall be elected by a simple majority vote of the Executive Committee. Honorary Councilors shall be recognized leaders in the field of Virginia natural history. No more than 10 Honorary Councilors shall exist at any time. Honorary Councilors shall be eligible to hold office in the Society.

Section 4. To be a Member in good standing a person must not be in arrears for dues. All annual dues for each ensuing year shall be due 1 January. Publications of the Society will be sent only to Members in good standing and to subscribing Institutions.

Article II. OFFICERS AND COMMITTEES

Section 1. The officers of the Society shall be a President, a Vice-President (President Elect), a Secretary-Treasurer, an Editor or co-editors, a webmaster and three Councilors.

Section 2. The President shall be the chairman of the Executive Committee and presiding officer at meetings of the Society, and appoint any Standing Committees of the Society and any other committees deemed necessary. The President casts only tie-breaking votes. The President shall serve a 2-year term beginning January 1st and ending December 31st, but will usually not serve for two consecutive terms. The President shall make periodic or annual reports which are published in *Banisteria*.

Section 3. The Vice-President shall be the President-Elect, shall be elected by the plurality of ballots cast by the Society's membership, and shall succeed to the Presidency in the event the office becomes vacant. The Vice-President shall be chairman of the Membership Committee, shall be responsible for coordinating with the local chairman arrangements for the scientific meetings of the Society, and shall preside over all meetings in the absence of the President.

Section 4. The Secretary-Treasurer shall be elected by a plurality of the ballots cast by the Society's membership for a 4-year term. The Secretary-Treasurer shall record all the proceedings of the Society, supervise all official mailings including the Society's publications, respond to all inquiries pertaining to membership, subscriptions, and Society matters, and maintain the membership and subscription lists. The Secretary-Treasurer shall be responsible to the Executive Committee to whom an annual report shall be made. The Secretary-Treasurer shall compose a summary of the Committee and General Business Meetings. The Secretary-Treasurer shall be in charge of all funds, keep the financial records of the Society, and be responsible for an independent yearly audit. The Secretary-Treasurer shall summarize the financial health of the Society and submit it for publication in *Banisteria*.

Section 5. Editor or Co-editors shall be appointed to a 2-year term of office by the Executive Committee. Editor shall be responsible for preparation of the semiannual journal *Banisteria*, and for maintaining high scholarly standards in its content. The Editor shall be responsible to the Executive Committee to whom an annual report shall be made.

Section 6. The Webmaster shall maintain and update the Society website and provide an annual report to be published in *Banisteria*.

Section 7. The Executive Committee shall be the governing body and shall consist of the Executive Council in addition to the President, the Vice-President, the Secretary-Treasurer, the Editor (or co-editors), Webmaster, and the last three Presidents. The Executive Council shall consist of three Councilors. Three Members in good standing who do not hold other Society offices shall be elected, one in each of three successive biennia with staggered terms by a plurality of the ballots cast by the Society's membership to serve 4 year terms as councilors. Councilors shall be eligible for reelection 2 years after the expiration of their previous terms.

Section 8. A quorum of the Executive Committee shall consist of one more than half of its Members and must include the President or Vice-President. Decisions shall be made by simple majority of those Members present.

Section 9. Vacancies in the staff of officers shall be filled by appointments approved by the majority of the remaining Members of the Executive Committee, except in the case of presidential vacancy (see Article II, Section 3). An appointee shall hold office only for the remainder of the term of his or her predecessor. Interim appointments of officers shall not constitute elected tenure.

Article III. MEETINGS

Section 1. The Society shall sponsor such Scientific Meetings as it deems advisable. The objectives of the Society's meetings shall be to present appropriate scientific papers and to foster the exchange of ideas among persons interested in Virginia natural history.

Section 2. There may be an annual General Meeting held sometime during a Scientific Meeting. Notice of this meeting shall be made with the notice of the Scientific Meeting (see Section 6 below). Those present shall constitute a quorum.

Section 3. The Executive Committee shall meet at some time during each meeting of the Society and at other times if deemed necessary by the President. As occasion demands, the Secretary, at the direction of the President, may submit matters to the Executive Committee for vote by mail or e-mail ballot. All such votes by the Executive Committee shall be placed on record and submitted for ratification at the next meeting of the Executive Committee.

Section 4. The Vice-President shall recommend the time and place of Annual Scientific Meetings. The Executive Committee shall give final approval to such recommendations.

Section 5 Notice of a Scientific Meeting shall be published in *Banisteria*, when possible.

Section 6. All Meetings, except Scientific Meetings, shall be conducted under Robert's Rules of Order.

Article IV. ELECTIONS

Section 1. The President, Vice-President, Secretary-Treasurer, and Councilors shall be elected by mail or on-line ballot from a list of nominees. Willingness of the nominees to serve shall be secured before their names are placed on the ballot. The Webmaster shall be appointed by the President.

Section 2. Ballots shall present a choice of at least two candidates for each of the offices of President-Elect, Secretary-Treasurer, and Councilor if possible.

Section 3 The President shall notify the candidates for office of the election results and an announcement of the election results shall be published in the first issue of *Banisteria* following.

Section 4 A tie vote for any office shall be resolved by a secret ballot of the Executive Committee.

Article V. FINANCES

Section 1. All funds received by the Society shall be used for publication of all official publications of the Society, and to defray other expenses incurred in the conduct of Society business as determined by the Executive Committee. Society Business includes but is not limited to the following:

a. Publication of *Banisteria*.
b. Publication of meeting programs.
c. Rental fees for meeting rooms and monetary support of symposia, bioblitzes etc.
d. Registration fees and provision of advanced monies for the purposes of scientific meetings.
e. Annual audit.
f. Postage and duplicating costs for ballots, reports for the Executive Meeting, and other official mailings of the Society.
g. Maintenance of the website and domain.

Section 2. No part of the net earnings of this Society shall ever inure to, or for the benefit of, or be distributable to its members, trustees, officers, or other private persons, except that the Society shall be empowered to pay reasonable compensation for services rendered, and to make payments and distributions in furtherance of the exempt purposes for which it was formed.

Section 3. A yearly audit of Society finances shall be made, as provided in Article II, Section 4.

Section 4. In the event that the Society shall cease to exist, after paying or adequately providing for the debts and obligations of the association, the remaining assets shall be distributed to a non-profit fund, foundation, or corporation, which is organized and operated exclusively for scientific, educational, and/or charitable purposes and which has established its tax exempt status under the appropriate Section of the Internal Revenue Code. The specific non-profit organization or organizations to receive any remaining funds may be determined and approved by the Executive Committee.

Article VI. PUBLICATIONS

The Society shall publish such scientific publications as authorized by the Executive Committee. Members enjoy waived or reduced page charges when publishing in *Banisteria*.

Article VII: DUES

Annual dues shall be determined by the Executive Committee and shall be due before the first day of each year.

Article VIII: FISCAL YEAR

The fiscal year of the Society shall coincide with the calendar year.

Article IX: AMENDMENTS TO THE ARTICLES OF INCORPORATION

Section 1. Proposed amendments to the Articles of Incorporation may be originated by the Executive Committee or by written request addressed to the Secretary and signed by at least 10 Members or by a simple majority of Members at a General Business Meeting of the Society.

Section 2. Voting on proposed amendments shall be by mail. The Secretary-Treasurer shall mail copies of proposed amendments and ballots to all members of the Society and shall allow one month for their return, the due date being stated on the ballot. An affirmative vote by two-thirds of the ballots cast by the Society's membership shall be necessary for adoption of an amendment to the Articles of Incorporation. Each proposed amendment shall be accompanied by a concise statement of its purpose, and comparison with the existing provisions, if any.

Section 3. The Secretary-Treasurer shall count and record the vote on an amendment and shall immediately notify the Executive Committee of the result. The result of the voting shall be announced to the membership of the Society in the next official issue of the journal.

Article X. AMENDMENTS TO THE BYLAWS

Bylaws for the conduct of the business of the Society may be enacted, amended, or repealed by a simple majority vote of the Executive Committee.

Instructions for Authors

Banisteria accepts manuscripts that contribute to the public and scientific knowledge of the natural history of Virginia. This publication is intended to be an outlet for the kind of information that is useful but would not be accepted in the mainstream journals. Information found in field notebooks and files that never made it into scientific journals is especially important. Manuscripts derived from natural history observations, small-scale field projects, distribution surveys and reviews, species inventories, reports for contracted environmental projects, and unpublished theses are especially desired. The focus of *Banisteria* is classical and therefore slanted toward organismal biology. Biographies of naturalists influential in the field of Virginia's natural history are welcomed by the editor, who will also consider publishing obituaries of recently deceased Virginia naturalists. The journal also is suited for papers on the history of natural history as it pertains to Virginia.

To qualify for publication in *Banisteria*, a manuscript must pertain in some way to the flora, fauna, geology, geography, climatology or Native Americans of the Commonwealth. The editor may consider manuscripts on any aspect of natural history from neighboring states if the information concerns a species native to Virginia or the topic is directly related to regional natural history. Papers may be full length or shorter contributions (notes). The editor will be happy to assist authors during the preparation of their manuscripts, because he would rather help get natural history information published for others to use than to have it remain on the shelf or in someone's desk.

All manuscripts should be sent to the editor (steve.roble@dcr.virginia.gov), who will in turn seek two peer reviews. Manuscripts, including figures and tables, should be submitted electronically as email attachments. Microsoft Word format is preferred, but pdf format is also acceptable. If this is not possible, submit three copies of your manuscript printed on standard size paper (8.5 x 11") using double spacing throughout. Contact the editor before attempting to submit files larger than 10 MB. For non-electronic submissions, authors should retain both the original typescript and figures until final acceptance for publication. Photocopies are adequate for review purposes. Please do not attempt to produce "camera-ready copy." One of the associate editors will serve as the editor for any papers written by the editor.

All manuscripts, including Shorter Contributions and Historical Contributions, should be arranged in the following order: **title, author's name, author's address, abstract, key words, text, acknowledgments, literature cited, tables, figure legends, figures**. Long manuscripts should have standard sections (e.g., Materials and Methods, Results, and Discussion), although some papers may not be amenable to such division, and short manuscripts (<4-6 pages) need not have these sections. All pages should be numbered, including tables. The title should be concise but informative. The title and the author's name and address should be centered at the top of the first page. Key words should not duplicate words that appear in the title. The text should begin on the first page beneath the abstract and key words. Use good judgment on arrangement of sections when other than the standard approach is necessary. Use only one blank space between sentences. Words should not be hyphenated. Use italics (or underlines) for species' scientific names.

As appropriate, authors should identify the nature of any required research or collecting permits and approvals (e.g., animal care and use guidelines), and the disposition of voucher specimens collected as part of their study.

Literature Citations: Use the following as a guide for proper format. **Do not abbreviate journal names**.

Journal article with 1 author:

Carr, L. G. 1965. Floristic elements in southwestern Virginia: a phytogeographical consideration. Castanea 30: 105-145.

Journal article with 2 authors:

Hoffman, R. L., & S. M. Roble. 2000. Fourteen ground beetles new to the Virginia fauna (Coleoptera: Carabidae). Banisteria 16: 36-40.

Journal article with 3+ authors:

Wagner, D. L., J. W. Peacock, J. L. Carter, & S. E. Talley. 1995. Spring caterpillar fauna of oak and blueberry in a Virginia deciduous forest. Annals of the Entomological Society of America 88: 416-426.

Book (capitalize title):

Mitchell, J. C. 1994. The Reptiles of Virginia. Smithsonian Institution Press, Washington, DC. 352 pp.
Chapter in a book:

Handley, C. O., Jr. 1979. Mammals of the Dismal Swamp: a historical account. Pp. 297-357 *In* P. W. Kirk (ed.), The Great Dismal Swamp. University Press of Virginia, Charlottesville, VA.

Report:

The Nature Conservancy. 1975. The preservation of natural diversity: A survey and recommendations. Report to the U.S. Department of Interior, Washington, DC. 189 pp. (include report series and number if present).

Thesis:

Ostby, B. J. K. 2005. Characterization of suitable habitats for freshwater mussels in the Clinch River, Virginia and Tennessee. M. S. thesis, Virginia Polytechnic Institute and State University, Blacksburg, VA. 203 pp.

Websites:

Virginia Botanical Associates. 2016. Digital Atlas of the Virginia Flora. c/o Virginia Botanical Associates, Blacksburg, VA. http://vaplantatlas.org/. (Accessed 1 December 2016).

Tables: Each table should be appear on a separate page, using a font size of 10 or larger. A caption for each table should follow the number and must be on the same page as the table. Ruled, horizontal lines should be avoided except at the top and bottom of the table. Remember that **each table must fit within a space of 6.5 x 8.5 inches**, and that reduction may cause loss of detail.

Figures: Black and white line drawings are acceptable for publication. Electronic submissions are preferred (jpeg, tiff, etc.). Original figures should be more than twice the size of final production size, and if several are assembled as a plate, keep the ratio of height to width consistent with the rectangular shape of the page. If submitting originals, the back of each figure should be labeled with the author's name. Color figures will be considered for publication if the author is prepared to pay $75 per color page in the journal.

Photographs: *Banisteria* will accept high contrast black and white or color photographs. Electronic submissions are preferred (jpeg, tiff, etc.). If submitting originals, they should be at least 5x7 inches and mounted if possible. Remember that reduction to fit column or page width will cause some loss of detail. The back of each photo should be labeled with the author's name. Color photographs will be published only if the author is prepared to pay $75 per color page in the journal. Otherwise, photographs will be printed in grayscale, provided that the contrast is acceptable.

Abbreviations: The following common abbreviations are accepted in *Banisteria*: n (sample size), no. (number), SVL (snout-vent length; define on first usage), DBH (diameter at breast height), yr (years), mo (months), wk (weeks), h (hours), min (minutes), s (seconds), P (probability), df (degrees of freedom), SD and SE (standard deviation and standard error), ns (not significant), l (liter), g (gram), mm (millimeter), and C (degrees Celsius). Male and female symbols may also be used if appropriate. Do not abbreviate dates or undefined terms.

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Page charges: Page charges are waived if the sole or first author is a member of the Virginia Natural History Society. Society members with grant funds are encouraged to contribute toward printing costs. Authors of manuscripts not meeting these criteria will be accessed page charges at a rate of $20 per printed page. **All authors** are responsible for the printing costs of color figures and photographs at a rate of $75 per color page.

Book reviews: Original reviews of new books relevant to Virginia or regional natural history should be submitted to the society's newsletter editor, Paul Marek, at pmarek@vt.edu.

Student Membership Incentive

Recognizing that students interested in natural history represent the main pool of prospective future members of the Virginia Natural History Society, the Executive Committee of the Society is soliciting nominations from our members for a **free one-year membership in the Society** to selected college, university, and high school students. We believe that receiving this membership will make more students aware of the Society and appreciate the benefits of continued membership. The Society will fund up to twenty students in 2016-2017. Nominees should be undergraduate or graduate students at a college or university in Virginia, or outstanding high school students, who are particularly interested in natural history. Nominators should be members of the Society and provide the following information for up to three students: Name, institution, mailing address, e-mail address, and a short paragraph describing the students' interests in and activities related to Virginia natural history. Nominations should be sent to the Secretary-Treasurer, Rachel Goodman at rgoodman@hsc.edu.

Hexastylis virginica (L.) Small. (Virginia Heartleaf)

Original drawing by John Banister, sent to Bishop D. H. Compton in 1689. Figure 55 in folio in Sir Hans Sloane's MS 4002 in the British Museum. Photocopy courtesy of Joseph and Nesta Ewan.

Virginia Natural History Society

http://virginianaturalhistorysociety.com/

General Information

The Virginia Natural History Society (VNHS) was formed in 1992 to bring together persons interested in the natural history of the Commonwealth of Virginia. The VNHS defines natural history in a broad sense, from the study of plants, animals, and other organisms to the geology and ecology of the state, to the natural history of the native people who inhabit it. The goals of the VNHS are to promote research on the natural history of Virginia, educate the citizens of the Commonwealth on natural history topics, and to encourage the conservation of natural resources.

Dissemination of natural history information occurs through publication of the journal *Banisteria*, named for John Banister (1650-1692) who was the first university-trained naturalist to work in Virginia. The first issue was published in 1992, and the journal is published twice per year in spring and fall. Articles cover a wide array of subjects, and prospective authors are encouraged to submit manuscripts on any aspect of natural history in Virginia; papers may pertain to Virginia or regional archaeology, anthropology, botany, ecology, zoology, paleontology, geology, geography, or climatology. Book reviews, biographies, obituaries, and historical accounts of relevance to natural history in Virginia also are welcomed. Manuscripts are peer-reviewed for suitability and edited for inclusion in the journal.

Page charges ($20/page) are waived if the sole or first author is a VNHS member. All authors must pay $75/page if they desire color printing of figures. The society's website contains detailed instructions for authors and the titles, abstracts or full PDF versions of articles from past *Banisteria* issues.

Memberships

The VNHS is open to anyone with an interest in natural history and welcomes participation by all members in society activities and efforts to promote education and conservation. Membership includes a subscription to *Banisteria* and invitations to periodic symposia and field events. Annual dues for members are $20 (per calendar year); library subscriptions are $40 per year. Checks should be sent to the Secretary/Treasurer, who also has most back issues of *Banisteria* available for sale. The VNHS is a tax-exempt, nonprofit, society under Section 501(C)3 of the IRS. We welcome donations to support our mission in Virginia.

Virginia Natural History Society

Application for Membership

Name _____

Address_____

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Zip Code _____

Phone _____

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Area(s) of Interest _____

ANNUAL DUES AND SUBSCRIPTIONS TO *BANISTERIA*

(memberships and subscriptions are by calendar year; subscribers/members outside the United States should add $3.00 for additional postage)

- ☐ $500.00 Life (not annual)
- ☐ $300.00 Benefactor
- ☐ $100.00 Patron
- ☐ $50.00 Supporting
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- ☐ $25.00 Family
- ☐ $20.00 Regular
- ☐ $5.00 Student (see below)
- ☐ I have added a contribution of $_____ to my membership dues.

The special student rate is applicable only when accompanied by the following certification signed by a faculty advisor (students are also eligible for a 1-year free membership if an advisor's nomination is approved by the society's Executive Committee; see nomination guidelines in *Banisteria*).

Institution _____

Advisor _____

Date_____

Make checks or money orders payable to:
Virginia Natural History Society

Send membership form and dues to:
Dr. Rachel Goodman, Secretary-Treasurer
Virginia Natural History Society
Box 74
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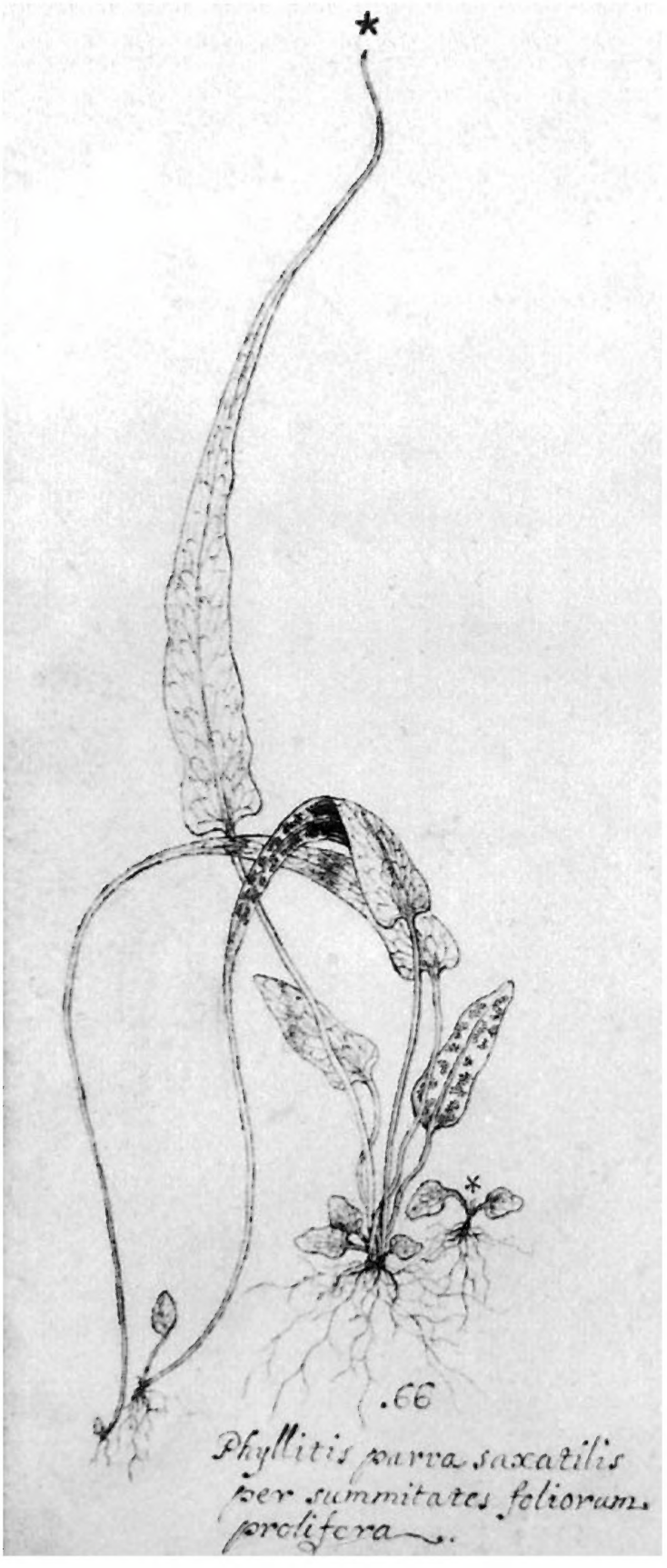
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